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A SYSTEM OF OPERATIVE SURGERY

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A SYSTEM OF OPERATIVE SURGERY

BY VARIOUS AUTHORS

EDITED BY

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IN FOUR VOLUMES

VOL. II

OPERATIONS FOR TUBERCULOUS AFFECTIONS OF THE BONES AND JOINTS
OPERATIONS UPON THE LIPS, FACE, AND JAWS
OPERATIONS UPON THE TONGUE, TONSILS, PHARYNX, AND OESOPHAGUS
OPERATIONS UPON THE STOMACH AND INTESTINES

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EDITOR'S PREFACE

GREAT as have been the advances made in Surgery during the last fifteen years, there is no direction in which they have been more noticeable than in the elaboration of those comparatively small but important details of operative technique which do so much to ensure a low mortality and a successful result.

These improvements have been developed simultaneously throughout the whole of the vast field covered by modern Surgery, and it has become increasingly difficult for any single writer to deal with such an important subject as Operative Surgery in an authoritative and efficient manner. The scope of the subject is so wide that it is difficult to ensure that the work when published shall be thoroughly up to date, while a second and even greater difficulty is for any one, however great his ability and experience, to deal equally exhaustively and authoritatively with all of the many branches of which he would have to treat.

To avoid both of these difficulties and thus to make sure that the work shall reflect faithfully the present position of British Operative Surgery, the plan has been adopted of securing the co-operation of a number of prominent British Surgeons. Each writer deals with a branch of the subject in which he has had special experience, and upon which, therefore, he is entitled to speak with authority.

Besides the two important points just referred to, a third equally important one has been kept in view throughout. Particular care has been taken to make the work of as much practical utility to the reader as possible. Not only are the various operations described in the fullest detail and with special

reference to the difficulties and dangers and the best methods of overcoming and avoiding them, but the indications for the individual operations are described at length, and the after-treatment and results receive adequate notice.

It is therefore hoped that the work will be useful alike to those who are about to operate for the first time, and to those surgeons of experience who desire to keep themselves informed as to the progress that has been made in the various branches of Operative Surgery.

The division of the work into a number of sections each written by a different author, necessarily involves some overlapping of subjects and some diversity of opinion upon points of technique. Efforts have been made to prevent overlapping of subjects as far as possible by care in their distribution and by conference between the authors concerned, but no attempt has been made to harmonize conflicting views. Each author supports his individual opinions by the weight of his authority, and any discrepancies may be taken to represent the absence of unanimity on various minor points that is well known to exist among surgeons of all countries.

The task of editing a work contributed to by so many writers might well appear to be an onerous one, but, owing to the promptitude, courtesy, and forbearance of all concerned, it has been a source of great pleasure, and the Editor's most cordial thanks are tendered to all those who have devoted so much time and trouble to the work.

PREFACE TO VOLUME II

MR. STILES desires gratefully to acknowledge his indebtedness to four of his former House Surgeons—to Mr. Lewis J. Beesly, F.R.C.S. (Edin.), Demonstrator of Anatomy in the University of Edinburgh, for the invaluable assistance he has given him in preparing the dissections from which the figures illustrating his articles have been drawn; and to Mr. D. P. D. Wilkie, F.R.C.S. (Edin.), to Mr. W. L. Robertson, F.R.C.S. (Edin.), and to Mr. L. Fourie, F.R.C.S. (Edin.), for the careful and painstaking manner in which they have gone over his Hospital records and followed up old cases for the purpose of ascertaining the results of the various operative procedures he has described.

Mr. Fagge is indebted to the kindness of Prof. Richardson and Dr. Sauerbruch for figures illustrating his article upon Œsophageal Operations, and Mr. Makins to Dr. W. J. Mayo of Rochester, Minnesota, U.S.A., Prof. Henri Hartmann, Dr. G. H. Monks, and Dr. Dobson for allowing the use of original illustrations. Mr. A. E. Barker desires to thank Prof. T. Kocher and Drs. Cushing and Halsted for leave to copy figures from their monographs.

Mr. Swinford Edwards is much indebted to his friend and colleague Mr. Aslett Baldwin for valuable assistance in the revision of proofs, while Mr. H. T. Butlin desires to take this opportunity of thanking the medical men who have given him information on the later histories of their patients—a most important requisite in the compilation of a table of results

such as Mr. Butlin is able to publish, and one often very difficult to obtain.

Most of the illustrations are original and have been made by the artists direct from sketches or actual preparations furnished by the various authors. To the artists—and particularly to Mr. S. A. Sewell, who has often had to work under great disadvantages—the Editor is under great obligations. Messrs. Allen and Hanburys, Mayer and Meltzer, and J. H. Montague have kindly lent a number of blocks illustrating surgical instruments.

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CHAPTER I

OPERATIONS FOR TUBERCULOUS OSTEOMYELITIS OF THE DIAPHYSES OF THE LONG BONES

The operations upon the disease as it occurs in the long bones proper, that is to say, in those possessing an epiphysis at each end of the diaphysis, will be considered first. The seat of election for the disease to attack these bones is, in the writer's experience, undoubtedly the growing extremities of the diaphyses.

As the tuberculous focus in the end of the diaphysis develops, it sooner or later comes to invade the neighbouring structures. The nature of the operative treatment will not only be influenced by the particular bone involved, but will depend also on the extent and route of spread of the lesion, namely, whether it has made its way into the joint, into the soft parts outside the joint, or up the shaft of the bone. When the epiphysis is small, as is the case, for example, with the upper epiphysis of the femur and the lower epiphysis of the humerus, the adjacent diaphyseal extremities are very closely related to the cavity of the joint, as they are separated from it merely by the periosteum and the synovial membrane, with more or less intervening synovial fatty tissue. These anatomical relationships explain why the hip and elbow become so early involved secondary to a primary bone focus. In such cases the primary osseous lesion is dealt with at the same time that the joint is operated upon. When, however, the epiphysis adjacent to the juxta-epiphyseal focus is a large one, as is the case, for example, with the upper epiphysis of the humerus and the lower epiphysis of the femur, the neighbouring joint generally escapes. The disease meanwhile tends to advance either up the diaphysis or to the surface of the bone outside the joint.

In addition to the primary localized juxta-epiphyseal focus so commonly met with, we occasionally have to deal with tuberculosis of the diaphysis in a more diffuse form. It is this form of the disease which will be specially referred to under the heading of tuberculous osteomyelitis of the diaphysis. Although apparently of rare occurrence in other European countries, as well as in the American and Australian continents, it is by no means rare, at any rate in this country, as the writer has operated on upwards of fifty cases of the affection in the Royal Hospital for Sick Children, Edinburgh, during the last ten years.

fore, that a skiagram should always be taken before proceeding to operation, as it shows exactly how much bone requires to be removed.

As the tuberculous focus enlarges, first the cancellous, then the cortical, and ultimately the new subperiosteal bone becomes invaded at



FIG. I. UPPER TWO-THIRDS OF THE DIAPHYSIS OF A TIBIA RESECTED FOR TUBERCULOUS OSTEOMYELITIS. From a child aged 10 years. The upper end of the diaphysis was wrenched away from the epiphysis. The specimen is bisected, exposing two sawn surfaces. The light shadow represents an elongated and somewhat irregular caseous focus. Note the thick layer of new subperiosteal bone, especially posteriorly where the disease has reached the cortex. (*Photograph by Mr. Richard Muir.*)

OPERATIONS FOR PRIMARY TUBERCULOUS OSTEOMYELITIS OF THE DIAPHYSIS

Primary tuberculous osteomyelitis of the diaphysis may start either in the spongy tissue at some distance from the epiphyseal cartilage or in the medullary canal, and in each situation the disease may present itself as a more or less circumscribed focus, or it may take the progressive infiltrating form, originally described by König. Occasionally the infiltration may involve the entire length of the medullary canal. It not infrequently happens, however, that a primary focus, beginning in the juxta-epiphyseal region (the metaphysis), spreads as a tuberculous infiltration into the medullary cavity, so that it is not always possible to draw a sharp distinction between metaphyseal and diaphyseal (medullary) tuberculosis.

The circumscribed form of the disease generally occurs as a soft, caseous, avascular focus, surrounded by an advancing zone of active tuberculous tissue, which is of a greyish colour, semi-translucent, and slightly vascular. The surrounding bone, apart from its increased vascularity, may appear almost normal ; in some cases it is rarefied, while in others again, especially if the disease be very chronic and tending to heal spontaneously, it is more or less sclerosed. Sometimes the focus contains one or more small sequestra, but even when the sequestrum is single, it is seldom of large size. Only rarely is the focus represented by a chronic abscess, and when this is the case the wall of the abscess very seldom presents the smooth sclerosed surface met with in the chronic staphylococcal abscess, known as Brodie's abscess.

The congestion set up in the surrounding bone by the presence of the tuberculous focus spreads through the Haversian systems to the periosteum, with the result that a formative osteoplastic periostitis is set up, and this gives rise to the deposit of a layer of new vascular and porous bone between the periosteum and the cortex. It is this sheath of subperiosteal new bone which gives to the disease its most important and characteristic diagnostic sign, namely, thickening of the diaphysis ; indeed, in the early stage of the disease this is the only physical sign present. Its importance, therefore, cannot be overestimated.

As the disease almost invariably occurs during childhood, congenital syphilis is the only affection with which it is likely to be confounded. There is seldom any difficulty in excluding the latter condition.

A good radiogram will not only confirm the diagnosis, but in many instances demonstrates quite distinctly the position, size, and shape of the focus, the presence or absence of a sequestrum, and the thickness and extent of the subperiosteal sheath of new bone. It follows, there-

bone and the eye made to project on the opposite side between the bone and the periosteum, the loop at the end of the wire saw is hooked into the eye by means of the slit above mentioned. By withdrawing the instrument, the saw is carried behind the bone; the handles are then hooked on, and the bone is sawn across. In young children the bones of the forearm may be snipped across with ordinary bone-forceps, but this instrument leaves a bruised and less even section, with the result that there is often some irregularity subsequently where the new bone joins the old. By using Gigli's wire saw, on the other hand, it is often almost impossible, even with a skiagram, to tell, after the new bone has completely developed, where the bone had been divided.



Fig. 2. Instrument for introducing Gigli's Wire Saw round the Bone. Used in resecting a portion of the diaphysis. See also Fig. 22.

After the diaphysis has been divided beyond one extremity of the lesion, a strong hook is introduced into the medullary canal, and while the divided end is forcibly dragged upwards the periosteum is separated from the deep surfaces of the bone until it is freed to a little beyond the opposite limit of the diseased focus. When this level has been reached, Gigli's saw is again applied and the bone divided. The sawn surfaces of the segment of bone removed are carefully examined to make sure that they are free from disease; if not, more bone must be removed.

If the disease has approached close to one end of the diaphysis, or if it has spread along it from a juxta-epiphyseal lesion, the diseased segment must be removed right up to the epiphysis. After sawing across the diaphysis, the separation of the diseased portion from the epiphysis is effected by seizing its divided end and wrenching it away from the epiphysis. When this has been done it will be found that the epiphyseal cartilage, instead of coming away with the diaphysis, is left firmly attached to the epiphysis. This is what one would expect on anatomical grounds; were it otherwise, the radical operation would be contra-indicated on account of the shortening which would result. As long as the disease has not actually involved the epiphyseal cartilage itself, the writer has found that the above operation does not give rise to any subsequent shortening.

one or other part of its circumference. Finally, the periosteum gives way, and a deep-seated abscess is produced; this sooner or later becomes superficial, and if left to itself ruptures externally, leaving a chronic sinus.

Operation. The operative treatment of primary tuberculous osteomyelitis of the diaphysis consists in the first place of freely exposing the bone for a little distance beyond the extent of the disease. The incision is so planned that the dissection occasions the minimum of injury to the soft parts. An intermuscular plane is chosen which avoids injuring more especially the nerve-supply to the muscles.

The method usually adopted is, after freely opening up the bone with a chisel, to thoroughly gouge and scrape away the diseased focus. This having been done, either some preparation of iodoform or pure carbolic acid is applied to the wall of the cavity; the latter is then stuffed with iodoform gauze or filled with Mosetig-Moorhof's iodoform-wax filling (see Vol I, p. 526).

While the above method is that which has been invariably employed by those surgeons who have recorded cases of this disease, the writer is strongly of opinion that such a procedure should be the exception rather than the rule. The early results of such a method of treatment are satisfactory enough, but unfortunately it too often happens that the patient sooner or later returns with the scar tuberculous and the seat of a sinus leading down to further disease in the bone. Such a result is not to be wondered at when we consider that it is almost impossible to remove all the affected area by the gouging process.

After a few such disappointments the writer has, for a number of years past, treated the affection by subperiosteal resection of the diseased part of the diaphysis. Care is taken to divide the bone well above and below the focus; in short, the disease is dealt with radically, as if it were a malignant tumour.

By the aid of skiagraphy the disease can be diagnosed in its early stage, before the focus has perforated the bone. This is the most favourable stage for operation, as the knife can be kept outside the infected area. No iodoform or other antiseptic need be applied to the wound, no stuffing is introduced, and the wound can almost invariably be closed without drainage.

The best instrument for dividing the shaft of the bone is Gigli's wire saw. This is passed round the shaft inside the periosteum, which has been previously thoroughly separated all round with a suitable elevator. For introducing the saw behind the bone the writer uses an instrument (Fig. 2) which resembles somewhat a broad flattened aneurysm needle with an oblique slit leading into a large eye placed as close as possible to its extremity. After the instrument has been passed behind the

ately from the periosteal tube. The operation is completed by closing the skin wound with interrupted sutures of silkworm-gut.

If a sinus already exists at the time of operation it should first of all be well scraped and disinfected with pure carbolic acid. The orifice should be excised by including it in an elliptical incision, which may either form part of the main incision or be independent of it; in the latter case it may be taken advantage of for drainage.

It not infrequently happens that, by the time the patient reaches the surgeon, the focus has given rise to a chronic abscess in the soft parts. As regards situation, it may be either subperiosteal, intermuscular, or more superficial, depending on its duration. In such a case an endeavour is made to plan the incision so that it will give free access to the abscess cavity as well as to the diseased bone. If this be not possible a separate incision must be made. The whole abscess cavity should be freely laid open and any outlying pockets of pus must be followed out. After the cavity and its ramifications have been thoroughly curetted, some sublimated iodoform-bismuth paste is rubbed into the wall. This preparation, which the writer uses in all tuberculous cases, consists of a mixture of one part of iodoform and two parts of subnitrate of bismuth stored in a 1–1,000 solution of perchloride of mercury. Enough for the operation is removed from the stock jar with a spoon and transferred to a small sterilized vessel. This mixture is preferable to dry iodoform, to the glycerine emulsion, or to the ethereal solution. Its advantages are that it is less toxic, so that more can be used, and that it forms rather more of a paste than sublimated iodoform alone.

After-treatment. The after-treatment consists in keeping the limb quiet in good position for a few weeks, after which it is put up in a suitable splint or in plaster of Paris until the new bone is sufficiently well developed to allow the patient to begin to use the limb. If the disease has not involved the periosteum, the new bone, as already stated, is perfectly re-formed in from three to six months (Fig. 24). If, on the other hand, the periosteum has been invaded by the disease, the reproduction is less perfect.

The steps of the more typical operations for the localized as well as the more diffuse varieties of tuberculous osteomyelitis of the diaphyses of the various long bones will be now described.

OPERATIONS FOR TUBERCULOUS OSTEOMYELITIS OF THE DIAPHYSIS OF THE HUMERUS

If the skiagram shows a limited focus of tubercle at the *upper end of the diaphysis*, thorough scraping will usually suffice to bring about a cure. A dissection is made so as to expose the surgical neck of the

The bleeding from the periosteal tube seldom amounts to more than a general oozing which soon ceases. Occasionally, the main nutrient artery requires to be ligatured. After the bleeding has practically ceased, the periosteal tube is closed with a buried catgut suture; care is taken to suture carefully the two extremities of the incision in the periosteum in such a way as to completely re-cover the sawn stumps of the bone. It is this precaution, combined with the use of Gigli's saw, which enables Nature to effect such a remarkably accurate fusion of the new bone with the old stump (Fig. 3). In suturing the periosteum, the writer prefers to use an interrupted rather than a continuous suture, for, should the periosteal tube become over-distended with blood, the tension is removed by some of the blood escaping between the sutures.

A few cutaneous catgut sutures are also employed to stitch the deep fascia, and, in the case of a deep bone such as the radius or fibula, the muscles are also stitched, either along with or separ-

Fig. 3. Skiagram of the Limb from which the Specimen seen in Fig. 1 was removed. Shows new formation of bone one year after the operation. Note the delicate transverse line of sclerosis at the junction of the new and old bone. Ossification is still somewhat incomplete towards the upper part of the new diaphysis. (*By Dr. E. Price.*)

above, the lower border of the teres minor; below, the teres major; externally, the surgical neck of the humerus; internally, the long head of the triceps.

After carefully isolating and freeing the above vessels and nerves they may be retracted downwards so as to give sufficient room for applying the gouge. The bone is opened up in the first instance immediately below the capsule, and in gouging away the focus care is taken not to open unnecessarily into the joint or to injure the epiphyseal cartilage.

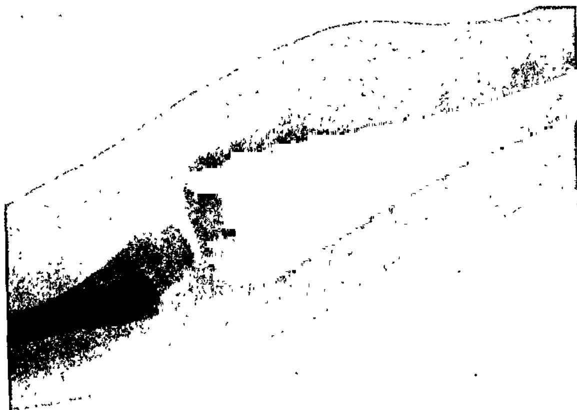


FIG. 5. SKIAGRAM SHOWING DIFFUSE TUBERCULOUS OSTEOMYELITIS OF THE LOWER THIRD OF THE DIAPHYSIS OF THE HUMERUS. From a child aged 1 year and 4 months. The disease has perforated the bone and given rise to a secondary abscess above the internal condyle. (*By Dr. H. Rainy.*)

Should the focus extend for some little distance down the shaft, the circumflex vessels and nerves are retracted upwards, and the opening in the bone is enlarged downwards immediately in front of the origin of the outer head of the triceps, the periosteum being previously incised and stripped backwards and forwards. After thoroughly scraping away all the disease, sublimated iodoform-bismuth paste is rubbed into the cavity, or the latter is filled with Mosetig-Moorhof's iodoform-wax filling. The wound is closed without drainage.

Resection of the upper third of the diaphysis of the humerus is merely an extension of the operation above described. Instead of

humerus, where it is free from muscular attachments, namely, beneath the posterior part of the deltoid, immediately *in front of the insertion* of the teres minor and the upper fibres of origin of the outer head of the triceps. As the bone is deeply placed, the incision must be a comparatively long one; it is made along the middle three-fifths of the posterior border of the deltoid. After dividing the integuments and deep fascia, the posterior border of the muscle is freed and retracted

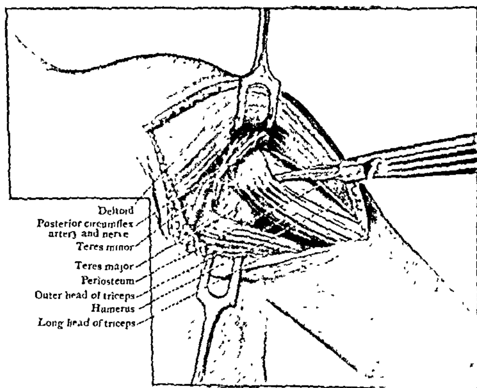


FIG. 4. EXPOSURE OF THE UPPER END OF THE DIAPHYSIS OF THE HUMERUS. The deltoid is retracted forwards, and the posterior circumflex vessels and nerve are seen coming through the quadrilateral space; the periosteum is divided longitudinally exactly in front of the upper part of the origin of the outer head of the triceps; a rugine is seen separating the periosteum from the bone.

well forwards. To reach the surgical neck of the humerus it will, as a rule, be found necessary to divide transversely the upper part of the *posterior fibres of the deltoid. Some of the* cutaneous branches of the circumflex nerve are divided, and forceps are applied to the accompanying superficial branches of the posterior circumflex artery. The lower border of the teres minor is now identified, and by following it to its insertion the humerus will be reached immediately above the surgical neck. The circumflex nerve and the posterior circumflex artery are then defined as they come through the quadrilateral space in the posterior wall of the axilla. The boundaries of this space as seen from behind are:

above, the lower border of the teres minor; below, the teres major; externally, the surgical neck of the humerus; internally, the long head of the triceps.

After carefully isolating and freeing the above vessels and nerves they may be retracted downwards so as to give sufficient room for applying the gouge. The bone is opened up in the first instance immediately below the capsule, and in gouging away the focus care is taken not to open unnecessarily into the joint or to injure the epiphyseal cartilage.

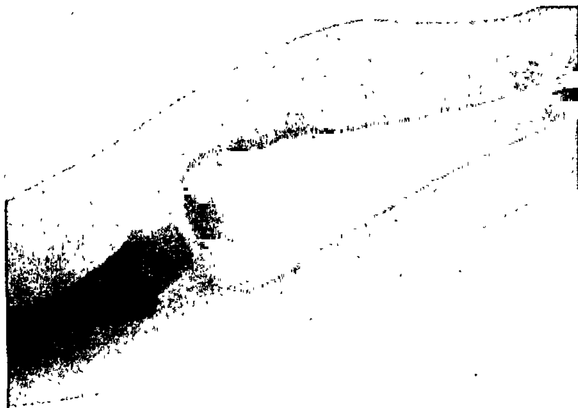


FIG. 5. SKIAGRAM SHOWING DIFFUSE TUBERCULOUS OSTEOMYELITIS OF THE LOWER THIRD OF THE DIAPHYSIS OF THE HUMERUS. From a child aged 1 year and 4 months. The disease has perforated the bone and given rise to a secondary abscess above the internal condyle. (*By Dr. H. Rainy.*)

Should the focus extend for some little distance down the shaft, the circumflex vessels and nerves are retracted upwards, and the opening in the bone is enlarged downwards immediately in front of the origin of the outer head of the triceps, the periosteum being previously incised and stripped backwards and forwards. After thoroughly scraping away all the disease, sublimated iodoform-bismuth paste is rubbed into the cavity, or the latter is filled with Mosetig-Moorhof's iodoform-wax filling. The wound is closed without drainage.

Resection of the upper third of the diaphysis of the humerus is merely an extension of the operation above described. Instead of

gouging into the bone, the periosteum is incised longitudinally from immediately below the capsular ligament downwards parallel to, and immediately in front of, the origin of the outer head of the triceps. The circumflex vessels and nerves are retracted upwards. The periosteum is divided in front of the outer head of the triceps, thereby avoiding the musculo-spiral nerve and the superior profunda vessels. After sawing across the humerus with Gigli's saw, and hooking up its divided



FIG. 6. SKIAGRAM OF THE ARM SHOWN IN THE PREVIOUS FIGURE. Taken four months after subperiosteal resection of the lower third of the diaphysis of the humerus. The elbow-joint has not been opened into. Note how well the lower end of the bone has modelled itself. There is slight angular deformity at the junction of the old and the new bone. *(By Dr. H. Rainy.)*

end in the manner already described, the periosteum and the three muscles inserted into the region of the bicipital groove are carefully separated from the bone, which is then wrenched away from its upper epiphysis. This can be done without opening into the joint. The periosteal tube is carefully sutured with catgut and the wound closed.

After-treatment. The after-treatment must be directed towards keeping the periosteal tube on the stretch so as to prevent shortening as well as angular deformity at the junction of the new with the old bone. For the first few weeks the patient is kept on his back with extension applied to the arm in the abducted position. After this the patient is allowed to get about with the limb in a rectangular splint



FIG. 7. SKIAGRAM SHOWING RE-FORMATION OF THE HUMERUS. Taken six weeks after subperiosteal resection of the lower two-thirds of the diaphysis for extensive tuberculous osteomyelitis in a child aged 6 years. The elbow-joint has not been opened into. Note the 'patchy' manner in which new bone is forming, and the ferrule of new subperiosteal bone surrounding the stump of the old bone. (*By Dr. E. Price.*)

and light weight extension applied to the lower fragment. In three months the bone is sufficiently re-formed to allow the patient to begin to use the arm.

In resection of the lower half of the diaphysis of the humerus the incision is begun on the back of the external condyle and carried vertically upwards immediately behind the external intermuscular septum as far as the musculo-spiral groove. The bone is reached by deepening the incision through the fleshy fibres of the inner head of the triceps. The musculo-spiral (radial) nerve and superior profunda vessels are carefully freed and retracted forwards and upwards. If the disease extends higher up than the middle of the shaft, some of the fibres of the outer head of the triceps must be divided in an upward and backward direction parallel to and behind the musculo-spiral nerve, the external cutaneous branches of which are divided. The periosteum is divided along the whole length of the wound, and the bone, after having been divided at the requisite level, is completely freed from the periosteum, and then wrenched away from the lower epiphysis. In spite of the fact that the capsule of the elbow-joint is attached to the diaphysis considerably above the level of the epiphyseal cartilage, it is interesting to note that on both occasions on which the writer has done this operation he was able to wrench the lower end of the diaphysis away from the epiphyseal cartilage subperiosteally without opening into the joint.

After-treatment. The after-treatment is practically the same as for resection of the upper half of the diaphysis. As soon as the new bone has sufficiently formed to allow of the arm being flexed, passive movement is begun with the object of preventing stiffness at the elbow. It may be necessary to administer an anæsthetic on the first occasion this is done, and care must be taken not to fracture the new bone.

Results. In the four cases in which the humerus was operated on, from the lower third to the lower two-thirds of the diaphysis was resected. In all the cases there were tuberculous lesions in other bones. Primary union was obtained in three cases. One case healed slowly by second intention, but five years later the child was found to be in the best of health with no trace of tuberculous disease. In this case the humerus had re-formed unevenly and the arm was somewhat flail-like, though quite useful. In another case there was some angling at the junction of the old and new bone, which, however, was easily remedied by fracturing and splinting; six years later the functional result was found to be excellent, and the resected bone perfectly re-formed. In a third case where primary union was obtained, the child died about a year later, the cause of death being unknown. In the fourth and most recent case the humerus is re-forming well, and the result promises to be good.

OPERATIONS FOR TUBERCULOUS OSTEOMYELITIS OF THE DIAPHYSIS OF THE RADIUS

Cases requiring resection are more frequently met with in the bones of the forearm than in the humerus. Resection of the *lower third* or so of the radius ranks amongst the commonest of these operations. The incision is commenced a finger's breadth below the dorso-radial tubercle on the back of the lower end of the radius,—a tubercle which separates the groove for the extensor carpi radialis brevior from that for the extensor secundi internodii pollicis (pollicis longus)—and is carried vertically up

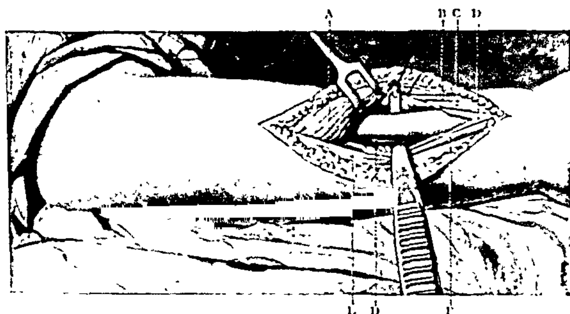


FIG. 8. RESECTION OF THE LOWER THIRD OF THE DIAPHYSIS OF THE RADIUS. The extensor pollicis brevis has been [illegible] [illegible] duced between the anterior aspect of the bone and the periosteum. A, Extensor pollicis brevis; B, Extensor carpi radialis longior; C, Extensor carpi radialis brevior; D, D, Periosteum; E, Extensor minimi digiti; F, Extensor pollicis longus.

the middle of the lower half of the back of the forearm. After ligaturing the divided ends of the commencement of the radial vein, the deep fascia, along with the upper part of the posterior annular (dorsal carpal) ligament, is divided, and the outer border of the extensor digitorum communis is identified and freed. Appearing from beneath this muscle are the fleshy fibres of the extensor ossis (abductor pollicis longus) and the extensor primi internodii pollicis (extensor pollicis brevis), which pass obliquely downwards and outwards over the back of the radius and the radial extensor of the wrist. To expose the radius the extensor digitorum communis is retracted inwards, while the fleshy bellies of the extensor ossis and extensor primi internodii pollicis are retracted well upwards

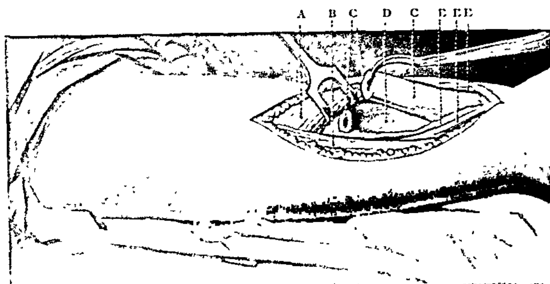


FIG. 9. FURTHER STAGE OF RESECTION OF THE LOWER THIRD OF THE DIAPHYSIS OF THE RADIUS. The diaphysis has been divided and hooked upwards to enable the periosteum to be separated from the anterior aspect of the bone. A, Extensor pollicis brevis; B, Extensor minimi digiti; C, C, Radius; D, Periosteum; E, E, E, Extensor pollicis longus.

FIG. 10. SKIAGRAM SHOWING DIFFUSE TUBERCULOUS OSTEOMYELITIS OF THE LOWER HALF OF THE DIAPHYSIS OF THE RADIUS. From a child aged 7 years Note the thickening of the bone. The disease has commenced to invade the epiphyseal cartilage. (*By Dr. H. Rainy.*)



Fig. 11. Skiagram of the Limb shown in the previous Figure. Showing the condition six weeks after subperiosteal resection of the lower half of the diaphysis. Note the 'patchy' manner in which the new bone is forming. Owing to the involvement of the epiphyseal cartilage and adjacent periosteum the ultimate result showed some shortening of the radius and deviation of the hand towards the radial side. (*By Dr. H. Rainy.*)



Fig. 12. Skiagram showing Diffuse Tuberculous Osteomyelitis of the Lower Three-fourths of the Shaft of the Radius. From a child aged 1 year and 4 months. Note the great thickening of the bone, in the interior of which a large sequestrum is seen. (*By Dr. H. Rainy.*)

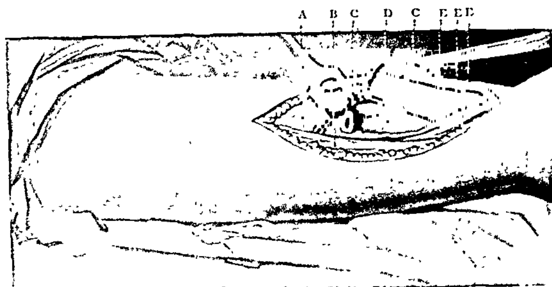


Fig. 9. Further Stage of Resection of the Lower Third of the Diaphysis of the Radius. The diaphysis has been divided and hooked upwards to enable the periosteum to be separated from the anterior aspect of the bone. A, Extensor pollicis brevis; B, Extensor minimi digiti; C, C, Radius; D, Periosteum; E, E, E, Extensor pollicis longus.

Fig. 10. Skiagram showing Diffuse Tuberculous Osteomyelitis of the Lower Half of the Diaphysis of the Radius. From a child aged 7 years Note the thickening of the bone. The disease has commenced to invade the epiphyseal cartilage. (*By Dr. H. Rainy.*)

intermuscular septum between it and the extensor carpi radialis brevior. In the floor of the wound there are exposed, from below upwards, the extensor primi internodii pollicis, the extensor ossis metacarpi pollicis, and finally the supinator brevis. The posterior interosseous vessels emerge between the two latter muscles, while the nerve pierces the supinator brevis a little above its lower border. Forceps are applied to the divided branches of the artery, but care is taken not to injure the nerve.

To expose the radius above the middle of its shaft, the fleshy belly

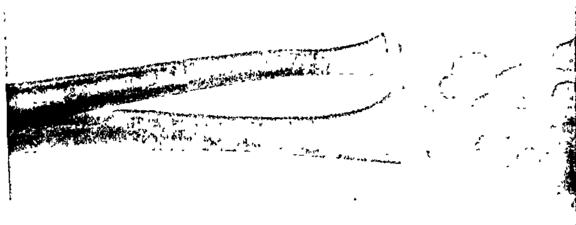


Fig. 14. Skiagram from the same Case as shown in the Two previous Figures, Six Years after Operation. Note the perfect re-formation of bone. (*By Dr. E. Price.*)

of the extensor carpi radialis brevior is retracted well forwards and outwards, while the extensor ossis metacarpi pollicis, previously retracted upwards and outwards, is now retracted in the opposite direction, namely, downwards and inwards. The periosteum is then incised longitudinally immediately external to the origin of the muscle, the incision being continued upwards so as to divide the lower fibres of the supinator brevis muscle parallel and external to the posterior interosseous nerve. The stump of the bone is now hooked upwards to enable the periosteum to be separated from the anterior aspect of the bone, which is then divided immediately below the bicipital tuberosity. In one case, where the disease extended still higher up, the writer was obliged to wrench the upper end of the bone away from the grasp of the orbicular (annular) ligament. When this had been done it was found that the upper epiphysis, which had not yet begun to ossify, had come away with the diaphysis.

and outwards. The fibres of the latter muscle are partly detached from their origin from the back of the radius. The periosteum is now divided longitudinally as far upwards as is necessary. The terminal branch of the posterior interosseous (deep radial) nerve dips beneath the extensor secundi internodii pollicis, and is therefore left uninjured at the ulnar edge of the wound. The terminal branch of the posterior interosseous artery may require to be ligatured. After dividing the radius and hooking it up into the wound, the periosteum is separated from the anterior aspect of the bone, and the latter is wrenched away from the lower



FIG. 13. SKIAGRAM FROM THE SAME CASE AS SHOWN IN FIG. 12. Showing the condition four months after subperiosteal resection of the greater part of the diaphysis. Note the rapidity with which new bone has formed; also the perfect junction (represented by the dark transverse linear shadow) between the old and the new bone towards the lower end of the diaphysis. (*By Dr. H. Rainy.*)

epiphysis. If the bone fractures across where it has been weakened by the disease, the lower portion can easily be shelled out separately.

In some cases operated on by the writer, the disease had involved *the greater part of the diaphysis of the radius* so that the bone had to be divided immediately below the bicipital tuberosity. In these cases the best plan is to resect the lower half or so of the bone in the first place, and then to complete the operation by continuing the dissection upwards until the bone is reached above the level of the disease. For this purpose the incision already described is continued upwards along the outer border of the extensor digitorum communis, so as to open up freely the

intermuscular septum between it and the extensor carpi radialis brevior. In the floor of the wound there are exposed, from below upwards, the extensor primi internodii pollicis, the extensor ossis metacarpi pollicis, and finally the supinator brevis. The posterior interosseous vessels emerge between the two latter muscles, while the nerve pierces the supinator brevis a little above its lower border. Forceps are applied to the divided branches of the artery, but care is taken not to injure the nerve.

To expose the radius above the middle of its shaft, the fleshy belly

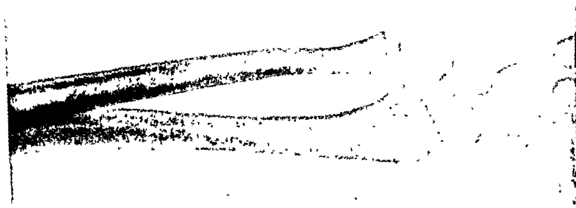


FIG. 14. SKIAGRAM FROM THE SAME CASE AS SHOWN IN THE TWO PREVIOUS FIGURES, SIX YEARS AFTER OPERATION. Note the perfect re-formation of bone. (*By Dr. E. Price.*)

of the extensor carpi radialis brevior is retracted well forwards and outwards, while the extensor ossis metacarpi pollicis, previously retracted upwards and outwards, is now retracted in the opposite direction, namely, downwards and inwards. The periosteum is then incised longitudinally immediately external to the origin of the muscle, the incision being continued upwards so as to divide the lower fibres of the supinator brevis muscle parallel and external to the posterior interosseous nerve. The stump of the bone is now hooked upwards to enable the periosteum to be separated from the anterior aspect of the bone, which is then divided immediately below the bicipital tuberosity. In one case, where the disease extended still higher up, the writer was obliged to wrench the upper end of the bone away from the grasp of the orbicular (annular) ligament. When this had been done it was found that the upper epiphysis, which had not yet begun to ossify, had come away with the diaphysis.

The immediate result was satisfactory, but it is too early to say what the ultimate result will be as regards deformity and function. The operation is completed by suturing the periosteum, and after this has been done the adjacent edges of the extensor digitorum communis and the extensor carpi radialis brevior are united by a few catgut sutures so as to close the fascial envelope and repair the intermuscular septum.

If the disease be confined to the *middle third* of the radius, the bone may be more easily reached by placing the incision further outwards and passing between the fleshy belly of the supinator longus (brachio-radialis)

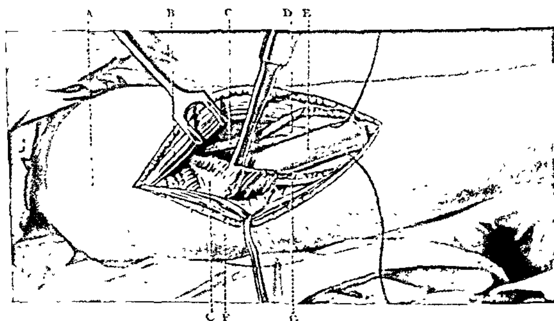


FIG. 15. RESECTION OF THE UPPER THIRD OF THE DIAPHYSIS OF THE RADIUS. The extensor carpi radialis brevior has been retracted forwards, the extensor digitorum communis backwards; the supinator brevis has been incised a little in front of the posterior interosseous nerve. The rugine separates the supinator brevis along with the periosteum from the upper third of the bone. A, External condyle; B, Extensor carpi radialis brevior; C, C, Supinator brevis; D, Periosteum; E, Radius; F, Extensor digitorum communis; G, Posterior interosseous nerve.

and the upper part of the tendon of the extensor carpi radialis longior. In the floor of the wound are the lower fibres of the supinator brevis, and immediately behind them the insertion of the pronator radii teres. The periosteum is incised immediately behind the latter tendon, and the incision is continued upwards through the lower fibres of the supinator brevis external to the posterior interosseous nerve.

After-treatment. The important point in the after-treatment is to prevent shortening of the radius during its re-formation. Should this occur the hand will become deviated to the radial side. The best way to prevent this deformity is to keep the hand well adducted to the ulnar

side until the bone has completely re-formed, that is to say, for about six months. This is most conveniently done by the application of a pistol-splint, shaped out of a strip of aluminium.

Results. In the thirteen cases in which resection of portions of the diaphysis of the radius was performed, the entire diaphysis was resected in three, and the upper two-thirds in two, while the lower part of the radius to the extent of two-thirds to less than a half was resected in the other cases. As a rule the bone has re-formed well, and the functional results are excellent, but in some there is slight shortening of the radius with consequent deviation of the hand to the radial side.



FIG. 16. SKIAGRAM OF RATHER LESS THAN THE LOWER HALF OF THE DIAPHYSIS OF THE ULNA. From a child aged 7 years. It was resected for a localized tuberculous focus which had perforated the cortex and produced a subperiosteal abscess. (*By Dr. E. Price.*)

OPERATIONS FOR TUBERCULOUS OSTEOMYELITIS OF THE DIAPHYSIS OF THE ULNA

Tuberculous osteomyelitis of the diaphysis of the ulna is frequently met with in the region of the olecranon and upper part of the shaft. As the bone is so superficial, the thickening and tenderness produced by the secondary periostitis soon become manifest. This is fortunate, as the operation should be undertaken before the focus has had time to produce an abscess followed by a sinus, and especially before the disease has had time to extend to the joint. As the greater part of the articular extremity is developed from the diaphysis, it follows that it is impossible to remove its upper end without opening into the joint. The surgeon is obliged, therefore, to fall back on gouging as the routine operation in dealing with the disease in the upper end of the diaphysis of the ulna.

Operation. The incision is carried down to the bone over the centre of the olecranon and along the posterior border of the shaft for a variable distance, depending on the extent of the disease. Care must be taken not to open into the joint at the upper end of the incision. In separating the periosteum the anconeus will be detached along with the outer flap, while the extensor carpi ulnaris will be partly detached with the inner flap. The bone is freely gouged into and the focus thoroughly scraped out. This is one of the situations in which a sequestrum is not infrequently met with. After introducing sublimated iodoform-bismuth paste or Mosetig-Moorhof's iodoform-wax

filling into the bony cavity, the periosteum is sutured with catgut and the wound closed without drainage.

If an abscess exists, with the skin over it beginning to be involved, it is better, instead of making a vertical incision through the damaged skin, to make a longitudinal curved incision through the healthy skin just beyond the abscess. The flap having been reflected, its deep surface, which forms the superficial wall of the abscess, is carefully freed from all tubercle, partly by scraping and partly by the aid of scissors curved on the flat. If there be a possibility of the joint being involved, the above curved incision is made along the outer margin of the abscess, so that,



FIG. 17. SKIAGRAM SHOWING NEW FORMATION OF BONE ELEVEN WEEKS AFTER RESECTION. From the same case as the previous figure. (*By Dr. E. Price.*)

should the joint require to be resected, the incision may be prolonged upwards over the posterior aspect of the radio-humeral joint and behind the external intermuscular septum. The entire incision is then practically the same as that recommended by Kocher for excision of the elbow-joint.

It is not necessary to describe in detail the steps of the operation for resection of the lower half or more of the diaphysis. The incision is of course made along the posterior subcutaneous border.

After-treatment. In the after-treatment an aluminium pistol-splint is applied so as to carry the hand as far as possible to the radial side. When the wound is healed a plaster or starch bandage may be substituted for the splint.

Results. Of the eleven cases in which a portion of the diaphysis of

the ulna was resected, the lower part to the extent of one to two thirds was resected in eight cases. The upper end was scraped in two cases, while the upper half was resected along with the elbow-joint in another case. The bone re-formed well in all the cases that could be traced except in one, where the middle third of the ulna has not re-formed at all and the other third is too thin ; the consequence is that the radius is a little bent where the ulna is deficient. A perfect functional result was obtained in three cases. In one case the elbow is completely ankylosed, pronation and supination being lost, but the patient's general health is good. The other cases have either been lost sight of, or have been too recently operated on to enable one to estimate the permanent result.

OPERATIONS FOR TUBERCULOUS OSTEOMYELITIS OF THE DIAPHYSIS OF THE FEMUR

The epiphyseal cartilage at the upper end of the femur is at the junction of the head and neck ; it follows, therefore, that a juxta-epiphyseal lesion is situated in the intracapsular portion of the neck of the bone and that the joint is soon involved. If, by the aid of skiagraphy, the focus be detected before the joint is invaded, the treatment should be conservative rather than operative, as it is almost impossible to remove all the disease without opening into and damaging the joint.

When the tuberculous focus is situated in the greater trochanter, a free incision is carried vertically over it, midway between its anterior and posterior borders. After splitting the aponeurotic insertion of the gluteus maximus (and, if necessary, nicking it a little on either side so as to admit of its being more easily retracted), the outer aspect of the trochanter is exposed, overlapped above and anteriorly by the insertion of the gluteus medius, while immediately below its root is the upper part of the vastus externus (lateralis). If the lesion be a limited one this single vertical incision is sufficient for the purpose of separating the periosteum and muscular attachments, but if it be more extensive it is better to separate them by means of an inverted T-shaped incision. The superior perforating branch of the profunda artery is divided and ligatured. The chisel (or gouge) is now applied and the bone is sufficiently opened up to allow of the disease being removed under control of the eye. After applying sublimated iodoform-bismuth paste to the cavity, the periosteum and muscular attachments are sutured back into position. A second row of sutures unites the aponeurosis of the gluteus maximus, and the wound is closed without drainage. Should a sinus be present, it must be disinfected with pure carbolic acid, or, better still, excised, and part of the wound should be left open for the introduction of a strip of iodoform gauze.

After-treatment. The limb should be kept absolutely at rest for some months, and to avoid subsequent bending of the neck (coxa vara) no weight should be borne on the limb for about a year from the date of operation. The patient, however, may be allowed to get about by means of

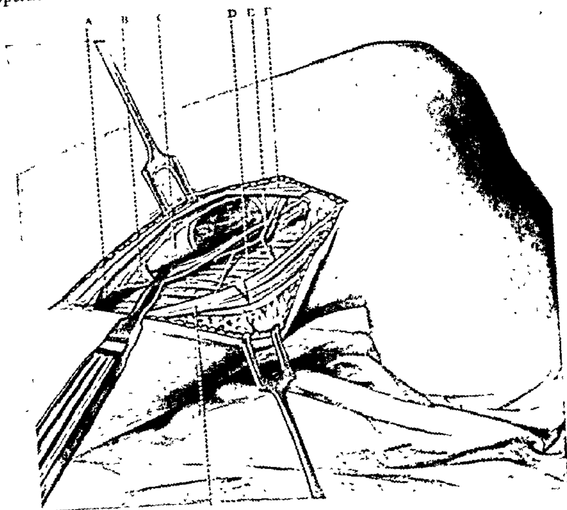


FIG. 18. EXPOSURE OF THE OUTER ASPECT OF THE LOWER THIRD OF THE DIAPHYSIS OF THE FEMUR. The ilio-tibial band has been split longitudinally and nicked transversely; the external intermuscular septum has been opened up, exposing the short head of the biceps and the anastomosis between the profunda artery and the superior external articular branch of the popliteal; the rugine separates the split periosteum from the posterior aspect of the diaphysis of the femur; the bone is opened into. The focus of disease is usually situated nearer to the condyle. A, Vastus externus; B, Periosteum; C, Femur, D, Biceps, E, Anastomosis between profunda and popliteal arteries; F, F, Ilio-tibial band.

a Thomas's hip-splint, a patten being added to the boot of the sound limb.

It is advisable to have a skiagram of the hip taken every two or three months so that the progress of the repair may be watched. By this

means the surgeon is able to form a correct estimate as to when the patient should be allowed the free use of the limb.

Tuberculous osteomyelitis is comparatively common in the *lower end of the diaphysis of the femur* in the region of the trigone, and in the early stage it generally occurs as a more or less circumscribed focus limited to one or other supracondyloid region. As the disease advances the trigone becomes perforated, with the result that sooner or later a deep-

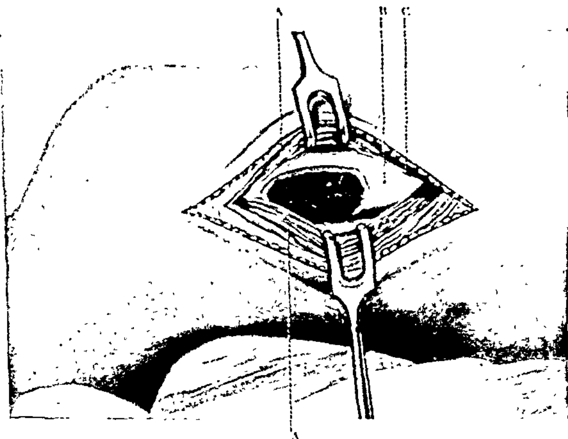


Fig. 19. Exposure of a Tuberculous Focus in the Internal Supracondyloid Region of the Femur. The vastus internus (medialis) and periosteum have been split and the edges of both retracted; the bone has been opened into. A, A, Vastus internus; B, Femur; C, Periosteum.

seated abscess forms in the popliteal space. It is due largely to the readiness with which the focus makes its way through the trigone above the attachments of the capsular ligament, that the knee-joint itself owes its escape.

When the focus involves the *external supracondyloid region* an incision is carried from the posterior part of the outer surface of the external condyle upwards along the line of the external intermuscular septum, which separates the vastus externus from the biceps. By deepening the incision in the plane of the septum and forcibly drawing apart the

adjacent muscles by suitable retractors, the bone is at length reached. In dividing the periosteum care must be taken not to injure the superior external (lateral) articular artery, which lies close to the bone just above the external condyle. To enable the periosteum to be sufficiently stripped off the trigone it is generally necessary to make two short transverse incisions through the membrane at each extremity of the vertical incision. The lower transverse incision should be placed just above the superior external articular artery, which is displaced downwards along with the periosteum.

When the disease is in the *internal supracondyloid region*, the dissection down to the bone is made either in front of or behind the tendon of the adductor magnus, depending upon the exact position of the focus.

In the first method the incision is begun over the middle of the internal condyle, and is carried upwards a little in front of the sartorius. In the floor of the wound the oblique fleshy fibres of the vastus internus (medialis) are exposed and divided a little in front of the tendon of the adductor magnus so as to avoid wounding the deep branch of the anastomotic (genu suprema) artery. The loose cellular tissue between the vastus internus and the femur is opened into, and by retracting the edges of the divided muscle the bone is freely exposed. The superior internal articular artery is avoided, if possible.

To expose the trigone behind the tendon of the adductor magnus, an incision is carried upwards from the adductor tubercle between the sartorius and gracilis anteriorly, and the semi-tendinosus and semi-membranosus posteriorly Retractors are now introduced and the dissection is deepened until the tendon of the adductor magnus is reached. By retracting it forwards and inwards along with the sartorius and gracilis (the semi-tendinosus and semi-membranosus along with the popliteal vessels being retracted backwards and outwards), the bone is freely exposed. The periosteum is incised immediately behind the internal intermuscular septum, which passes from the tendon of the adductor magnus to the internal supracondyloid ridge.

In chiselling the bone and gouging out the focus, care should be taken not to injure the epiphyseal cartilage unnecessarily. Should the bone focus be complicated by an abscess, either in the popliteal space or under the vastus internus, it must be thoroughly curetted, and, if possible, excised completely, the incision being enlarged for the purpose. The wound may generally be closed without drainage.

After-treatment. A Thomas's knee-splint is worn for some months so as to prevent the patient bearing any weight on the limb. If this precaution be not taken, the leg is liable to become deviated in consequence of unequal growth of the two supracondyloid regions.

In dealing with tuberculous osteomyelitis of the *shaft of the femur*,

instead of resecting a complete segment of the bone, it is wiser to perform the less radical operation of gouging. In doing this, however, the medullary cavity should be very freely opened up.

The *lower half of the shaft* is best reached by dividing the vastus internus in the interval between the rectus muscle and Hunter's canal. For this purpose the incision is made in a line directed from the middle of the internal condyle towards the anterior superior spine of the ilium. No important vessels or nerves are injured. The incision is in front of the large nerve to the vastus internus. As this muscle merely covers, instead of arising from, the inner surface of the femur, there is no difficulty in retracting its divided edges so as to obtain sufficient room to incise and separate the periosteum.



FIG. 20. SKIAGRAM SHOWING TUBERCULOUS OSTEOMYELITIS OF THE UPPER END OF THE DIAPHYSIS OF THE FIBULA. From a boy aged 2 years. Note the sheath of new subperiosteal bone extending as far down as the junction of the upper with the middle third of the shaft. (*By Dr. H. Rainy.*)

To reach the *upper half of the shaft* an incision is carried down to the bone in the plane of the external intermuscular septum, which separates the vastus externus from the outer head of the biceps. To allow of sufficient retraction of these muscles the divided edges of the strong fascia lata must be deeply notched transversely. One or two perforating branches of the profunda artery will require to be ligatured.

In a boy aged twelve years, on whom the writer adopted this method

for a focus which occupied the upper third of the medulla, half the circumference of the shaft was removed for the extent of 3 inches. There was a small abscess at the bottom of the external intermuscular septum. In dealing with this the diseased portion of the septum and periosteum was excised, the remainder being united with buried sutures. Sublimated iodoform-bismuth paste was applied to the cavity, which was then lightly stuffed with iodoform gauze. The wound healed well, leaving, however, a sinus which closed two months later. The patient had been treated for some months for hip-joint disease. A skiagram was found to be a great help in revealing the exact nature and extent of the disease.

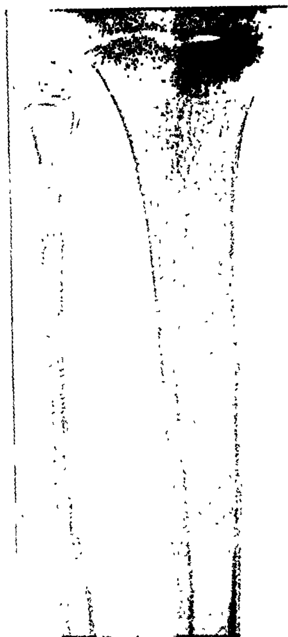


FIG. 21. SKIAGRAM FROM THE SAME CASE AS THE PREVIOUS FIGURE. Taken four years after resection of the upper third of the diaphysis of the fibula. (*By Dr. E. Price*)

OPERATIONS FOR TUBERCULOUS OSTEOMYELITIS OF THE DIAPHYSIS OF THE FIBULA

To reach the *shaft of the fibula* the dissection should be made along the intermuscular septum (posterior peroneal), which separates the peroneal from the flexor group of muscles, so as to avoid injuring the musculocutaneous (superficial peroneal) nerve, which occupies the septum (anterior peroneal) between the peronei and extensors. The first-mentioned septum corresponds to a line drawn from the outer side of the head of the fibula to the posterior border of the external malleolus.

In resecting the *upper third of the diaphysis* care must be taken not to injure the external popliteal (common peroneal) nerve, which passes obliquely downwards and forwards behind the head of the fibula to pierce the peroneus longus an inch below it. After dividing the integuments in the line of the septum, the outer border of the gastrocnemius is defined and retracted inwards. The fibular origin of the soleus is now exposed, and the intermuscular septum between it and the peroneus longus is incised down to the bone, the popliteal nerve having previously been freed and retracted forwards. After separating the periosteum, the bone is divided well below the disease and either wrenched away from the upper epiphysis or snipped across at its neck. The periosteal tube is closed by catgut sutures, which should include the adjacent muscles, namely, the soleus and peroneus longus.

To resect the *middle third of the fibula*, the gastrocnemius and soleus are retracted inwards and the periosteum is divided between the flexor hallucis longus and the peronei.

The *lower third of the shaft* is resected through an incision passing between the peroneus brevis and tertius muscles. Care must be taken to keep below and external to the cutaneous termination of the musculo-cutaneous nerve.

After-treatment. After the wound has healed the limb should be put up in plaster for three months, or a Thomas's knee-splint may be worn instead.

OPERATIONS FOR TUBERCULOUS OSTEOMYELITIS OF THE DIAPHYSIS OF THE TIBIA

The diaphysis of the tibia is a comparatively frequent seat of diffuse tuberculous osteomyelitis. The disease may attack any part of the diaphysis, and occasionally the whole medullary canal is involved. The bone being superficial, its thickening is easily made out, and the disease is, fortunately, generally recognized before either the periosteum or the tissues outside the bone become involved.

The skin incision is carried down to the bone along the middle of its subcutaneous surface, the length of the wound depending, of course, on the extent of the bone to be resected. When the resection includes the *upper end of the diaphysis*, the incision is continued upwards on to the internal tuberosity in front of the insertions of the sartorius and inner hamstrings. In separating the periosteum it is important to keep close to the bone along the line of attachment of the interosseous membrane. The membrane is rather more firmly adherent also at the ends of the

for a focus which occupied the upper third of the medulla, half the circumference of the shaft was removed for the extent of 3 inches. There was a small abscess at the bottom of the external intermuscular septum. In dealing with this the diseased portion of the septum and periosteum was excised, the remainder being united with buried sutures. Sublimated iodoform-bismuth paste was applied to the cavity, which was then lightly stuffed with iodoform gauze. The wound healed well, leaving, however, a sinus which closed two months later. The patient had been treated for some months for hip-joint disease. A skiagram was found to be a great help in revealing the exact nature and extent of the disease.

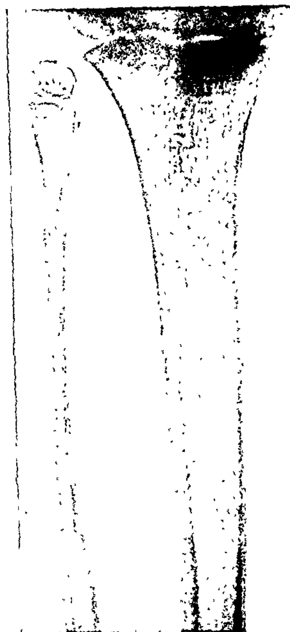


FIG. 21. SKIAGRAM FROM THE SAME CASE AS THE PREVIOUS FIGURE. Taken four years after resection of the upper third of the diaphysis of the fibula. (*By Dr. E. Price.*)

OPERATIONS FOR TUBERCULOUS OSTEOMYELITIS OF THE DIAPHYSIS OF THE FIBULA

To reach the *shaft of the fibula* the dissection should be made along the intermuscular septum (posterior peroneal), which separates the peroneal from the flexor group of muscles, so as to avoid injuring the musculo-cutaneous (superficial peroneal) nerve, which occupies the septum (anterior peroneal) between the peronei and extensors. The first-mentioned septum corresponds to a line drawn from the outer side of the head of the fibula to the posterior border of the external malleolus.

three months, but in an *older* patient a Thomas's knee-splint may often be substituted at this stage.

It was in consequence of the excellent results obtained from resections of large portions of the diaphysis of the tibia that the writer was induced to adopt the same radical treatment in dealing with all the other long bones except the femur.

When there is reason to fear shortening of the new tibia, as for example in cases where the focus has involved the epiphyseal cartilage, or the periosteum in its neighbourhood, extension should be employed; and it is a good plan to fracture the fibula at the same time that the tibia is operated on. By this means compensatory shortening of the fibula can take place by overlapping of the fragments. Deviation of the foot may thus be prevented.

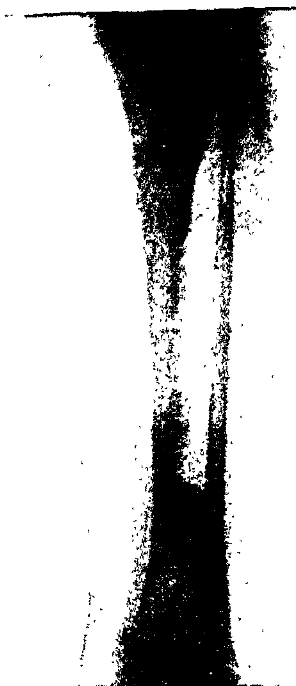


FIG. 23. SKIAGRAM SHOWING NEW FORMATION OF BONE. Eleven weeks after resection *of the middle two-fourths of the diaphysis of* the tibia for tuberculous osteomyelitis in a child aged 4 years. *(By Dr. H. Rainy.)*

Result. In the nine cases in which resection of a portion of the diaphysis of the tibia was performed, the amount of bone removed varied in extent from a third to the entire diaphysis. In almost all the cases the tibiæ have re-formed well, and the functional results are on the whole excellent. In one case where the greater part of the diaphyses of both tibiæ was removed six years ago, the bones have

diaphysis, and in these regions it should be separated as far as possible with a suitable elevator before attempting to wrench out the diaphyseal extremity.

The manner in which the bone is divided and shelled out has been fully described on p. 6. It is in the case of the tibia that the instrument shown in Fig. 2 is particularly useful.

If the greater part of the diaphysis of the tibia has been removed it may be necessary to insert a drain into the interior of the periosteal

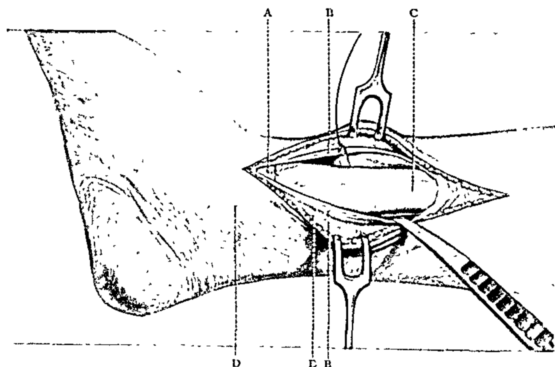


FIG. 22. RESECTION OF THE LOWER THIRD OF THE DIAPHYSIS OF THE TIBIA. The integuments and periosteum have been divided; Gigli's wire saw is hooked on to the separator, which has been passed between the periosteum and the posterior aspect of the bone. A, Epiphyseal cartilage; B, B, Periosteum; C, Tibia; D, Internal malleolus; E, Fascia.

tube for a few days, so as to drain off the serum from the blood-clot with which it becomes filled.

After-treatment. The limb should be placed either in a box-splint or on a suitable posterior splint, care being taken to keep the foot in good position. In about six weeks plaster of Paris is substituted for the splint; the bandage should extend well up the thigh, and during its application it is important to see that the foot is held in good position. The plaster case is changed at the end of two or three months, and a skiagram is taken to ascertain to what extent the new bone has formed. In the case of young children it is generally necessary to renew the plaster for another

CHAPTER II

OPERATIONS FOR TUBERCULOUS OSTEOMYELITIS OF THE SHORT LONG-BONES

Tuberculous osteomyelitis is very commonly met with in the short long-bones of the hands and feet, and it is very frequently associated with tuberculous bone and joint lesions in other parts of the body.

These short long-bones differ from the long bones proper, in that they have only one epiphysis, so that at one end of the bone the diaphysis forms the articular extremity, and it is through this extremity that the adjacent joint is liable to be infected. Owing to this peculiar mode of development, the shaft of the short long-bones cannot always be completely resected without opening into the joint at the anti-epiphyseal end of the bone, and, moreover, the operation of complete removal of the diaphysis is followed, comparatively, by more shortening of the digit than is the case with the long bones proper.

OPERATIONS FOR TUBERCULOUS OSTEOMYELITIS OF THE PHALANGES OF THE HAND

If rest and constitutional measures fail to bring about improvement, operation should be resorted to, otherwise one or other of the adjacent joints, or the flexor sheath, is liable to become involved.

Operation. The phalanx is exposed by two dorso-lateral incisions placed between the extensor tendons and the digital vessels and nerves. As pointed out by Kocher, the object of the bilateral incision is to prevent the lateral bending of the finger which would result from the cicatrization of a unilateral incision. The periosteum is separated first on one side and then on the other ; the separation is then continued distally under the capsular ligament as far as the neck of the bone, which is then snipped across with a small pair of bone-forceps. The divided end is grasped with necrosis forceps and wrenched away from the epiphysis at the proximal end. One or two buried catgut sutures are introduced at either side to bring together the tendinous expansion of the extensor tendons along with the periosteum. When the wound has healed extension should be applied to the finger with the object of diminishing shortening.

re-formed so completely that their skiagraphic appearances are practically normal (see Fig. 24). In some cases there is slight shortening along with some inwards deviation of the foot.



FIG. 24. SKIAGRAMS FROM SAME LIMB AS THAT IN THE PREVIOUS FIGURE. Taken six years after operation. Note the perfect re-formation of bone.

If the disease has spread to the metacarpo-phalangeal joint, and if the flexor sheath and the soft parts be extensively diseased, amputation of the finger along with the metacarpal bone will be called for (see Vol. I, p. 112).

In resecting the *second metacarpal bone*, the incision is made along its dorsal ridge, between the abductor indicis and the long extensor tendon. If it be found necessary to remove the carpal extremity along with the shaft, the proximal end of the incision must be kept internal to the radial artery, and the insertion of the extensor carpi radialis longior should be separated subperiosteally.

When the *fifth metacarpal bone* is diseased, the incision is made immediately to the ulnar side of the tendon of the extensor minimi digiti (digiti quinti proprius). The proximal end of the incision is kept superficial, so as not to divide the dorsal branch of the ulnar nerve which winds to the back of the wrist round the cuneiform (triquetral) bone. If the carpal extremity of the bone be also involved, the tendon of the extensor carpi ulnaris should be separated subperiosteally before completing the disarticulation.

After-treatment. The after-treatment consists in keeping the hand and wrist quiet for a considerable time by means of an anterior splint. In a young child, after the wound has healed, a convenient way of doing this is to apply a strip of aluminium, covered with boric lint, to the palmar aspect of the hand and the forearm from a little beyond the fingers almost to the elbow. This splint must be secured to the limb, not by a bandage, but by means of strips of plaster, applied directly to the skin, which should be previously disinfected and rubbed over with boric powder. A strip of boric lint should be placed between each of the fingers. Over the strapping a narrow bandage is applied, partly to ensure thorough adhesion, and partly to keep the plaster clean.

OPERATIONS FOR TUBERCULOUS OSTEOMYELITIS OF THE PHALANGES OF THE FOOT

With the exception of the first phalanx of the great toe, tuberculous affections of the phalanges of the foot are best treated by amputation at the metatarso-phalangeal joint.

The *first phalanx* is treated in the same way as in the hand, except that a single incision, made to the inner side of the extensor tendon, is preferable to a bilateral incision. The operation should be done before either of the neighbouring joints become involved. If the metatarso-phalangeal joint be allowed to become involved, the head of the metatarsal bone will generally have to be sacrificed, and this means serious damage

OPERATIONS FOR TUBERCULOUS OSTEOMYELITIS OF THE INTER-PHALANGEAL JOINTS

This condition is rarely primary, but should it occur, amputation of the finger would be much more frequently called for than excision of the joint. The latter operation is done through two dorso-lateral incisions. If possible, the excision should be done by the extra-capsular method.

OPERATIONS FOR TUBERCULOUS OSTEOMYELITIS OF THE METACARPAL BONES

When the disease affects the *first metacarpal bone*, every attempt should be made to preserve the thumb, either by scraping out the focus or by subperiosteal resection of the disease, if possible without opening into the adjacent joints.

Operation. The incision is made along the whole length of the bone immediately to the radial side of the tendon of the extensor primi pollicis (extensor pollicis brevis). If the incision be made to the ulnar side of this tendon, its proximal extremity must be kept superficial to the radial artery, and, if possible, the branches of the radial nerve should be identified and drawn aside. The periosteum is then divided between the origins of the abductor pollicis brevis and the abductor indicis muscles, which are separated from the bone along with the periosteum. In a young child the best way to resect the shaft of the bone is to cut it across with a knife at the junction of the epiphysis and the diaphysis; the extremity of the latter is then hooked upwards and the periosteum is carefully separated downwards from its palmar aspect until the neck of the bone is reached, where it is snipped across with forceps. A little sublimated iodoform-bismuth paste is applied to the inner surface of the periosteum, which is then closed by a few buried catgut sutures.

If the disease has spread to the *metacarpo-phalangeal joint*, amputation is generally necessary, in which case as much as possible of the periosteum of the metacarpal bone should be saved, with the object of obtaining a movable thenar eminence capable of approximation to the fingers.

In excising portions of the other metacarpal bones, the incision is made over the ridge separating the dorsal interosseous muscles, which are detached along with the periosteum. After dividing the skin the extensor tendon is exposed, freed, and drawn aside The bone is dealt with in the manner above described, the epiphysis, however, being at the distal instead of the proximal end of the bone. If the disease be extensive, it may be necessary to disarticulate its carpal extremity, and an attempt should be made to do this by the subcapsular method.

CHAPTER III

OPERATIONS FOR TUBERCULOUS OSTEOMYELITIS OF THE BONES OF THE VAULT OF THE SKULL

OPERATIONS FOR TUBERCULOUS OSTEOMYELITIS OF THE SKULL

This is a rare affection, occurring generally in children and young adults, and usually along with other osseous lesions.

Operation. To illustrate the operative treatment, we shall take as an example the commonest condition met with, namely, a soft caseous focus in the region of the frontal eminence, with a secondary abscess beneath the pericranium. A horseshoe incision is carried at once down to the bone a little beyond the upper three-fourths of the limit of the swelling. The flap, which should include the periosteum, is rapidly dissected downwards, forceps being applied to the more important bleeding points in the scalp. The anterior wall of the abscess, which is exposed on the deep surface of the flap, consists of the pericranium covered by caseous granulations. These are thoroughly scraped away with a sharp spoon, the membrane being held taut with artery forceps to facilitate the process. If the tubercle has eaten into the pericranium it is better to dissect this portion away completely. Attention is now turned to the bone. If an area of the outer table has already been destroyed and replaced by a cheesy focus, it is scraped away, and if the inner table has also been destroyed, a sharp spoon is applied to the dura. The surrounding tuberculous bone is then removed by snipping it away with a suitable pair of skull forceps, care being taken to see that the removal is carried well into the surrounding healthy bone. To enable this to be done the skin incision should, as mentioned above, be made some distance beyond the outline of the swelling; if this be not done, one, or it may be two, additional incisions will have to be made at right angles to the original incision. In those cases in which the disease has extended downwards towards the orbital margin, it must be carefully and persistently followed up. If complete removal of the disease cannot be effected without opening the frontal sinus, this should be done without hesitation. The writer found it necessary to do this on two occasions, and in neither instance did the procedure interfere with the normal healing of the wound.

to the foot. Fortunately the presence of the epiphysis serves very materially to arrest the spread of the disease from the diaphysis to the joint.

OPERATIONS FOR TUBERCULOUS DISEASE OF THE METATARSAL BONES

Tuberculous osteomyelitis of the *first metatarsal bone* is unfortunately a common affection, and one which calls for early operative interference if amputation of the toe at the tarso-metatarsal joint is to be avoided. A skiagram will reveal the extent of the disease. If the focus be limited the choice of operation will lie between gouging and partial resection. The latter procedure should be followed especially when the focus can be removed subperiosteally without opening into it, and without interfering either with the head of the bone or the neighbouring joints. If the disease extends up to the proximal end of the bone, the operator should have no hesitation in extending the incision upwards and disarticulating from the internal cuneiform. This is a more conservative plan in the end than opening into the diseased focus. In clearing the end of the bone, the capsule, along with the insertions of the tibialis anticus (anterior) and peroneus longus tendons, should, if possible, be separated along with the periosteum. Every attempt should be made to save the head of the bone.

Tuberculous disease of the other metatarsal bones is dealt with in a similar manner to the corresponding bones of the hand.

ficial so as to avoid injury to the facial nerve, the remainder is carried deeply down to the bone. The facial vessels are divided and ligatured, and forceps are applied to one or two veins in the substance of the parotid. After dividing the periosteum along the margin of the bone, the upper flap, together with the masseter and periosteum, is raised from the jaw with the aid of a periosteum elevator, and the same instrument is used to separate the internal pterygoid and periosteum from the inner surface of the bone. When the bone has been sufficiently laid bare, the saw is applied well in front of the disease and the division is completed with bone-forceps. The angle of the jaw is now grasped with lion forceps,



FIG. 25. SKIAGRAM OF HALF THE LOWER JAW. Taken after subperiosteal resection for tuberculous disease. Note the small sequestra, the slight carious excavations of the surface, and the displacement and loss of the teeth. *(By Dr. E. Price.)*

and, by applying torsion, both the condyle and the coronoid process may be wrenched away subperiosteally without opening either into the mouth or the temporo-maxillary joint. If the disease be advanced, the bone may break across during the twisting-out process, in which case the upper portion must of course be removed separately by the same manœuvre. The end of the torn inferior dental artery may sometimes be seen dangling from the inside of the periosteal tube ; the bleeding from it is usually arrested by the torsion, but, if not, the vessel is easily ligatured. The operation is completed by suturing the wound with silkworm-gut, an opening being left for the insertion of a gauze drain into the periosteal cavity.

In the cases in which the adjacent lymphatic glands are tuberculous

If all the disease in the bone be not removed, a persistent sinus is almost certain to result, and a second, and still more severe, operation will generally be necessary in order to bring about permanent healing.

Not infrequently, however, a cheesy abscess forms beneath the pericranium before the outer table has become destroyed. In such cases the bone subjacent to the disease has a more vascular and porous appearance than normal, and sometimes tiny buttons of granulation tissue can be seen projecting from its surface. These appearances afford sufficient indication that the diploë is diseased, but even if the above appearances are wanting, the diploë should be explored. This may be done either with a hammer and chisel, or by means of a trephine. If diploic disease be revealed the opening should be enlarged with forceps as above described.

When the disease produces a diffuse tumour-like thickening of the bone a large flap of scalp should be turned down, and the diseased bone removed either with a skull saw aided by the hammer and chisel, or, if preferred, by a circular saw driven by an electro-motor. Great care should be taken not to wound the dura. As long as this membrane is left intact, cerebral complications need not be feared.

The diseased bone having been removed, all cheesy matter and fungating granulation tissue is thoroughly scraped off the dura, which is then smeared over with a little sublimated iodoform-bismuth paste. The operation is completed by suturing the flap back into position. Drainage is seldom necessary.

OPERATIONS FOR TUBERCULOUS OSTEOMYELITIS OF THE LOWER JAW

This is a less common affection than is generally supposed. It occurs especially in the children of phthisical parents, and Stockman has shown that it is almost invariably the primary lesion in phosphorus necrosis of the jaw. The tubercle generally gains access to the bone through the alveolus of a tooth, but the writer has operated on a child with a large focus of tubercle in the ramus of the jaw in whom all the teeth were perfectly sound.

Operation. The operative treatment consists in subperiosteal resection of the portion of the jaw affected. If possible, this should be done before a cold abscess has developed, and especially before the stage of sinus formation followed by mixed infection.

When the ascending ramus only is involved, an incision is carried from immediately in front of the lobule of the ear downwards along the posterior margin of the ramus, round the angle, and thence for a variable distance forwards into the submaxillary region a little below the lower margin of the jaw. While the upper part of the incision is kept super-

Results. The results of resection of the lower jaw for tubercle are, as a rule, very satisfactory, especially if the greater part of the periosteum can be preserved. Considerable re-formation of bone takes place, the mouth can be well opened, and the only deformity consists in slight deviation of the chin towards the affected side.

OPERATIONS FOR TUBERCULOUS OSTEOMYELITIS OF THE UPPER JAW AND MALAR BONE

In children the upper jaw is the commonest seat of osseous tuberculosis of the face. The disease begins in the cancellated tissue in the neighbourhood of the malar process and floor of the orbit.

Operation. In the early stage of the disease (the proper time to interfere), the operation consists in making an oblique incision from a little below the middle of the infra-orbital margin outwards and slightly downwards over the malar bone for a variable length depending on the extent of the disease. This incision, which lies immediately above the infra-orbital foramen and the origin of the levator labii superioris muscle (caput infraorbitale), possesses the double advantage of running parallel to the natural folds of the skin as well as to the branches of the facial nerve. Should an abscess be present, its wall is dissected away, after which the periosteum is separated from the bone, and the tuberculous focus is removed either with a sharp spoon aided by a gouge, or by the hammer and chisel. The infra-orbital vessels and nerves should be avoided if possible, but it will often be necessary to open into the antrum. After applying sublimated iodoform-bismuth paste to the cavity, the wound is carefully sutured. An opening is left for the introduction of an iodoform-gauze plug.

When the alveolar process is involved, one or more of the permanent as well as the temporary teeth will almost certainly have to be sacrificed. After separating the gum and periosteum with a suitable elevator, the diseased portion of the jaw is snipped away with cutting forceps, the most suitable being a small pair of curved bone-forceps. In aggravated cases the greater portion of the upper jaw may have to be removed. The cavity left in the jaw is packed with a strip of gauze wrung almost dry out of turpentine.

and complicated with abscess and sinus formation, the incision may have to be modified somewhat so as to include the sinus, while to give access to the glands it will be necessary to prolong the incision further down into the neck as well as further forwards into the submaxillary region. After dissecting away the sinus and glands the bone is dealt with in the manner already described.

When the disease is limited to the *portion of the mandible between the angle and the symphysis*, the subperiosteal resection of the focus is a comparatively simple procedure. A straight incision is made parallel to, and a little below, the margin of the jaw. After detaching the periosteum along with the muscles from both aspects of the bone with a suitable rugine, the mouth is freely opened into by continuing the separation until the gums are also detached. The jaw is then divided in front of the lesion, after which it is seized with lion forceps and levered downwards and outwards so as to facilitate the more complete separation of the soft parts behind the lesion, where the bone is again divided. In the young child the division of the bone may be done with bone-forceps, while in the adult Gigli's wire saw is the better instrument.

After removing the bone, any remains of a sinus, or suppurating pocket, must be carefully disinfected, or, still better, dissected away altogether; care should be taken, however, not to remove more of the periosteum than is absolutely necessary. If by mixed infection the wound has been rendered very unhealthy, it should be swabbed with turpentine. This is probably the best antiseptic for the purpose, as, in addition to being a powerful antiseptic and deodorizer, it is also a valuable hæmostatic; it produces no sloughing, nor does it interfere in any way with the healing of the wound.

In addition to the skin sutures, it is an advantage to partially close the wound in the mouth by uniting the raw edges of the gums with sutures introduced from within the mouth. Drainage of the wound is provided for by the introduction of a rubber tube, one end of which is stitched to the skin wound, while the other just projects into the cavity of the mouth.

When the disease involves the greater part of the horizontal ramus, including the symphysis, tracheotomy should be performed at the same time that the bone is removed. If this precaution be not taken, the patient is very liable to become asphyxiated during sleep from the tongue falling back into the pharynx. Advantage may be taken of the tracheotomy to plug the pharynx so as to prevent any blood gaining access to the trachea during the operation. The writer has had two cases in children in which the tracheotomy tube had to be worn permanently. In one of the cases the child lost its life from asphyxia, owing to the tube, which had been removed during the day, not having been replaced at bedtime.

the upper cervical vertebræ. These processes constitute the surest guide to the abscess, the wall of which may often be seen and felt immediately in front of them, while in front of the abscess again is the internal jugular vein covered by its sheath. Care must be taken not to mistake the sheath of the vein for the wall of the abscess. In opening the abscess the edge of the knife is directed towards the vertebræ. The opening should be enlarged with forceps. It is better to expose the wall of the abscess by careful dissection rather than to trust to entering it blindly with forceps through a small incision (Hilton's method).

The cavity is gently curetted to remove as much of the pyogenic membrane as possible. Evacuation of the cheesy pus and membrane is greatly assisted by pressure made from the opposite side of the neck with gauze pads. Occasionally a loose sequestrum may be removed. The final cleansing of the cavity is most conveniently done by repeated packing with fresh strips of gauze. Before closing the wound some sublimated iodoform-bismuth paste is introduced into the cavity and rubbed into the lining with the finger. The wound may either be closed completely, or, if the cavity be large and the pus less cheesy, an iodoform-gauze drain may be left in for a few days. If, as not infrequently happens, the abscess be bilateral as well as large, a counter-opening may be made behind the opposite sterno-mastoid; this is readily done by cutting carefully down on the blades of a long pair of dressing forceps pushed across the neck immediately in front of the vertebral column. Advantage may be taken of the counter-opening to flush out the cavity with normal saline solution.

After-treatment. The after-treatment consists in immobilizing the head by means of sand-bags, weight extension being added if need be. Permanent healing of the wound sometimes occurs, but a sinus is very liable to persist for a considerable time. A second curetting may be necessary before healing is finally brought about. The duration of the subsequent fixation treatment will of course vary in different cases. The writer has seen complete paraplegia disappear very rapidly after merely opening the abscess.

PREVERTEBRAL THORACIC ABSCESS

This condition is often revealed by skiagraphy when there are no symptoms indicating its presence. The pus, having reached the surface of the vertebral column on one or other side of the anterior common ligament, accumulates, in the first instance, under the periosteum. After perforating the periosteum, it forms an abscess between the mediastinal pleuræ and the bodies of the vertebra.

CHAPTER IV

OPERATIONS FOR TUBERCULOUS OSTEOMYELITIS OF THE SPINE AND RIBS

TUBERCULOUS OSTEOMYELITIS OF THE SPINE

Abscesses secondary to tuberculous disease of the spinal column may occur in a variety of situations depending on the part of the spine involved. The course which the pus takes as the abscess enlarges depends partly on whether the patient is going about or recumbent during its development, and partly on the arrangement of the adjacent fascial planes.

PREVERTEBRAL CERVICAL ABSCESS

The tuberculous process, after reaching the anterior surface of the diseased vertebra and perforating the periosteum, invades the prevertebral muscles and forms a collection of pus between the cervical vertebræ and the prevertebral fascia. Abscesses secondary to tuberculous disease of the retro-pharyngeal lymphatic glands are, on the other hand, situated in front of the prevertebral fascia, between it and the wall of the pharynx. As the spinal abscess enlarges, it strips the prevertebral fascia off the prevertebral muscles and at the same time extends laterally behind the carotid sheath and the posterior layer of the sheath of the sterno-mastoid, to approach the surface usually at the upper part of the posterior margin of that muscle.

Operation. The abscess should be opened not from the mouth but from behind the sterno-mastoid, a procedure which was first employed and advocated by Professor Chiene. The incision is made immediately behind the upper third of the posterior border of the muscle, care being taken not to injure the spinal accessory nerve. If the abscess be situated lower down in the neck, the nerve should be deliberately exposed and retracted out of the way before proceeding with the deeper part of the dissection. The posterior border of the sterno-mastoid is freed, and it is well to divide some of its fibres transversely a little below the mastoid process so as to allow of further retraction of the muscle forwards. Behind the sterno-mastoid are the fibres of the splenius and levator anguli scapulæ, which are traced to their origin from the transverse processes of

periosteum and the posterior costo-transverse ligament, are then separated from the transverse process and its base is snipped through with a pair of curved bone forceps. The divided process is seized with lion (or necrosis) forceps held in the left hand while the knife is used to free it from the remaining ligamentous attachments, namely, from the superior costo-transverse ligament passing from the neck of the rib below to its lower border, and from the middle costo-transverse ligament which passes between its anterior surface and the posterior aspect of the neck of the rib with which it articulates.

The next step consists in the removal of the head, neck, and tubercle of the rib. The periosteum is first separated from the posterior aspect of the neck, and a strong hook is then inserted into the end of the divided rib which is dragged backwards while the periosteum is detached from its anterior aspect, carrying with it the costal attachment of the anterior costo-vertebral (stellate) ligament. When this has been done the freed portion of rib is seized with necrosis forceps and twisted away from the spine. The pleura is not injured. Care must be taken not to wound the intercostal vessels which pass outwards a little below the lower border of the neck of the rib.

If the forefinger be now introduced into the bottom of the wound, it will enter the abscess cavity which occupies the cellular tissue of the posterior mediastinum. By directing the finger forwards and inwards the lateral aspect of the corresponding vertebra, and of the one above it, can be distinctly palpated, its surface scraped, or a sequestrum removed. Anteriorly and externally is the reflection of the posterior mediastinal pleura on to the ribs. When an abscess is present, this membrane, along with the intrathoracic fascia, is considerably thickened, so that with ordinary care the pleural cavity should not be opened into. If more room be desired in order to reach the upper of the two vertebræ with which the rib articulates, the upper edge of the wound must be retracted, and a second transverse process removed; this will generally suffice without removing the vertebral end of the corresponding rib, but there should be no hesitation in excising it if still more room be required.

If the mediastinal abscess be small, it may be gently packed with iodoform gauze for a few days, and the wound then allowed to heal. As a rule, however, if the cavity be large, and especially if paraplegia be present, a drainage tube should be inserted and kept in for a considerable time.

If the abscess has penetrated through an intervertebral foramen into the spinal canal, or if it has encroached on the canal after destroying the body of the vertebra, it can be drained more satisfactorily and with

Indications. Under the influence of prolonged recumbency and open-air treatment, the primary disease often heals, in which case the abscess generally becomes absorbed. If, on the other hand, the abscess enlarges, the tension may become so great that the œsophagus, the trachea, and the left recurrent laryngeal nerve may be pressed upon, or paraplegia may result from the pus finding its way into the spinal canal. If the above complications occur in spite of efficient rest treatment, operation becomes imperative.

Operation. The abscess in the posterior mediastinum is best reached by removing one, or it may be two, of the costo-transverse articulations on one or other side, preferably the right. This method of posterior mediastinotomy, which was first performed by Heidenhain, was brought into prominence in the treatment of thoracic spinal abscess by Ménard, who gave it the appropriate name of *costo-transversectomy.*

The advantages of costo-transversectomy over resection of ribs external to the transverse process are, firstly, that more direct access is got to the bodies of the vertebræ, and, secondly, that the pleura is less liable to be injured. Heidenhain employed a longitudinal incision close to the spines and separated the superficial and deep muscles outwards off the laminæ as far as the tubercle of the rib. He resected the transverse process first and then the head and neck of the rib. He showed that the removal of only one costo-transverse articulation was sufficient to enable the surgeon to introduce the finger and strip the pleura and endothoracic fascia off the lateral aspect of the diseased vertebra.

Kocher warmly recommends the principle of Heidenhain's operation, but prefers an oblique incision followed by transverse division of the muscles. He carries his *incision from the most prominent spinous* process involved in the curve downwards and outwards exactly in the line of the rib to be resected.

After dividing the integuments, the trapezius, and then the rhomboids, the cellular interval is reached between these muscles and the fascia covering the divisions of the erector spinæ (sacro-spinalis) muscle. The longissimus dorsi and accessorius (ilio-costalis dorsi) are divided in the line of the original incision. The cross division of the deep muscles is of no moment as they possess a segmental nerve-supply. The bleeding which occurs is, according to Kocher, much less than that which results from Heidenhain's method of separating the muscles longitudinally from the spines and laminæ.

The periosteum of the exposed rib is divided for a short distance external to its tubercle. The muscular attachments, along with the

hypogastric and ilio-inguinal nerves. Occasionally one or other of these nerves can be felt crossing the cavity of the abscess.

When, on the other hand, the abscess is felt in the angle between the crest of the ilium and the outer edge of the erector spinæ (sacro-spinalis), the incision is made obliquely from above downwards and outwards, parallel to the posterior cutaneous branches of the lumbar nerves. The triangle of Petit is enlarged by dividing the outer border of the latissimus dorsi, and, beneath it, the quadratus lumborum and the middle layer of the lumbar aponeurosis. The abscess is now readily reached by blunt dissection carried inwards close to the front of the transverse process of the fourth or fifth lumbar vertebra.

In 1884 Treves advocated a more extensive dissection of the loin with the object not only of evacuating the abscess, but also of removing the osseous disease. Unfortunately, however, the nature and extent of the disease seldom admit of this being done, so that the operation has not come into general use. The tendency has been to confine operative treatment to the abscess alone, and to rely on prolonged rest and open-air treatment to bring about a cure of the osseous disease. The introduction of the Röntgen rays may possibly serve to revive the operation to some extent by enabling the surgeon to pick out those rarer cases in which the disease is located to one vertebra, and especially when it is represented for the most part by a sequestrum.

The following is Sir Frederick Treves's description of the operation (*A Manual of Operative Surgery*, vol. ii, p. 772): 'The patient's loin having been exposed, a vertical incision some 2½ inches in length is made through the integuments. The centre of this cut should lie about midway between the crest of the ilium and the last rib, and the cut should be so placed as to correspond to a vertical line parallel with the vertebral side of the outer border of the erector spinæ. . . .

'After cutting through the superficial fascia the dense aponeurosis is exposed which covers the posterior surface of the erector spinæ. . . . The dense aponeurosis with its attached muscular fibres having been divided in the full length of the incision, the erector spinæ is exposed. This muscle is at once recognized by the vertical direction of its fibres. The outer border of the muscle should now be sought for, and the whole mass drawn by means of retractors as far as possible towards the middle line of the back. In this way the anterior part of the sheath of the muscle, known as the middle layer of the fascia lumborum, is readily exposed. Neither in front nor behind has the erector spinæ any direct adhesion to its sheath at this part.

'The anterior layer of the sheath, as now exposed, is seen to be made up of dense white glistening fibres, which are all more or less transverse

infinitely less danger by costo-transversectomy than by laminectomy. The latter operation is reserved for those cases in which the paraplegia is due to external pachymeningitis and thickening of the dura, and for those rare cases in which the compression is caused by narrowing of the osseous canal itself.

Results. The results of costo-transversectomy are very satisfactory, especially when compared with those of laminectomy, in which the mortality is from 40 to 50%. Of the twenty-four cases of costo-transversectomy collected by Ménard, nineteen recovered; two of these had a recurrence of the paraplegia, while four died subsequently of tuberculosis. The paraplegia generally begins to disappear within a few days of the operation, and it is often completely recovered from in a month or two. The same may be said of incontinence of urine. It is not uncommon, however, for a fistula to persist for several months. If the paraplegia recurs, the fistula must be opened up and free drainage re-established.

When the disease has already found its way along the posterior branch of an intercostal artery into the erector spinæ compartment, all that is necessary is to open the abscess freely, to search for the sinus in its floor, and, after enlarging it, to follow the abscess to its source. If the sinus be found to lead into the posterior mediastinum, it should be enlarged with forceps rather than the knife; and if an intrathoracic abscess be discovered, the operator should proceed to do a costo-transversectomy.

LUMBAR ABSCESS

This is a complication of tuberculous disease in the lower dorsal and upper lumbar regions. The pus is more liable to make its way into the loin if the abscess develops while the patient is kept recumbent. The pus generally reaches the loin through one or other of its two weak areas. The upper is situated at the angle between the outer border of the erector spinæ (sacro-spinalis) and the twelfth rib, where the internal oblique is aponeurotic, the lower is at Petit's triangle.

An abscess appearing in the angle between the erector spinæ and the last rib is opened by an oblique incision a little below and parallel to the twelfth rib. The abscess is reached after dividing the latissimus dorsi (possibly also the lowest fibres of the serratus posticus inferior), the outer fibres of the quadratus lumborum, and the middle layer of the lumbar fascia. Not infrequently the abscess will be found to have already perforated the quadratus and the aponeurosis common to the internal oblique and transversalis muscles. If the opening in these structures be small, it must be enlarged, and care should be taken to avoid unnecessary injury to the last dorsal nerve and its companion artery, or to the ilio-

ILIAC ABSCESS

Operation. An iliac abscess is best opened through an incision, about 2 inches in length, placed a finger's breadth internal to the anterior superior spine of the ilium. After splitting the external oblique the fibres of the internal oblique and transversalis muscles may be either separated by blunt dissection or divided in the direction of the original incision. The floor of the wound is formed by the fascia transversalis, close to its junction with the fascia iliaca. To reach the cavity of the abscess and at the same time to avoid opening the peritoneum, the operator should keep outside the transversalis fascia and close to the anterior superior spine, so as to get behind the fascia iliaca. Either the deep circumflex iliac artery itself, or its ascending branch, is generally seen in the course of the dissection; the former should be avoided, but the latter may have to be divided and ligatured.

When the abscess has extended below Poupart's ligament into the thigh, a second opening should be made into it. The incision for this purpose is made a little below the anterior superior spine of the ilium, along either the inner or the outer edge of the sartorius, according to the direction in which the abscess has become most superficial. The abscess wall, formed by the thickened fascia covering the ilio-psoas, is reached by retracting the sartorius and by deepening the dissection internal to the tendon of the rectus.

As soon as the pus escapes the finger should at once be introduced into the abscess cavity and the opening dilated. If the abscess be allowed to empty itself before the finger is introduced there may be some little difficulty in finding the cavity again. When the abscess has been evacuated, as much as possible of the pyogenic membrane should be removed, either with the finger-nail or with a Barker's flushing spoon. If the latter be used it must be applied cautiously, especially towards the abdominal aspect of the abscess. Moreover, too vigorous use of the sharp spoon is liable to cause an unnecessary amount of hæmorrhage as well as severe shock. The detached portions of membrane and caseous débris are removed by copious irrigation aided by compression applied to the abscess through the abdominal wall. There is no advantage in adding an antiseptic to the water used to irrigate the cavity. Normal saline at 100° F. is the best solution to employ. Before closing the wound, ½ to 2 ounces (according to the size of the abscess) of glycerine containing 10% of iodoform in suspension may be injected into the cavity, as much as possible being squeezed out again before the wound is sutured. Or, instead of iodoform and glycerine, some iodoform-bismuth paste may be introduced into the abscess with a sharp spoon,

in direction. Through this sheath the transverse processes of the lumbar vertebræ should be sought for. The longest and most conspicuous process is that belonging to the third vertebra. It is readily felt. The erector muscle having been drawn as far as possible towards the middle line, the anterior layer of its sheath must be divided vertically as near to the transverse processes as convenient. By this incision the quadratus lumborum muscle is exposed. The muscle as here seen is very thin. It is composed of fibres which run from above obliquely downwards and outwards. Between the fibres are tendinous bundles which spring from the tips of the transverse processes. The muscle should be divided close to the extremity of a transverse process, and the incision cautiously enlarged until the muscle is divided to the full extent of the skin wound. It is at this stage that there is danger of wounding the abdominal branches of the lumbar arteries. The inner edge of the quadratus is overlapped by the psoas muscle, so that when the former is divided the latter is exposed. The psoas fibres, as now seen, take about the same direction as the posterior fibres of the quadratus—*i. e.* run downwards and outwards. The interval between the two muscles is marked by a thin but distinct layer of fascia, known as the anterior lamella of the fascia lumborum. Some of the tendinous fibres of the psoas having been divided close to a transverse process, the finger is introduced beneath the muscle, and gently insinuated along the process until the anterior aspect of the bodies of the vertebræ is reached. The incision in the psoas can be enlarged to any extent.

'With common care there should be no danger of opening up the subperitoneal connective tissue, much less of wounding the peritoneum. All risk on this score will be avoided by making the incision in the quadratus as near to the transverse processes as possible.

'Great care must be taken not to wound the lumbar arteries. The abdominal branches of these vessels run for the most part behind the quadratus lumborum. That, however, from the first vessel runs in front, and not infrequently those from one or two of the larger arteries follow its example. These vessels may be of large size—often as large as the lingual. They may be avoided, as well as the trunks from which they arise, by keeping close to a transverse process. The main vessel curves around the spine between the transverse processes, and between these processes also the division of the artery occurs. If, therefore, the rule be observed of always reaching the spine along a transverse process, the lumbar arteries and their abdominal branches need be exposed to no risk.'

abscess and the affected muscle *en masse* the risk of infecting the soft tissues is greatly diminished. A careful examination is next made of the diseased rib with a view of ascertaining the nature and extent of the mischief. Should a sinus be found leading into a small focus in the interior of the rib, a portion of the latter including the diseased focus should be resected subperiosteally. The operation is simplified by resecting the bone subperiosteally in the first instance and then dissecting away any disease which may be left behind in the periosteum and adjacent muscle. The intercostal vessels will generally have to be divided and ligatured. Care must be taken, however, not to injure the pleura.

Should an abscess exist between the pleura and the chest-wall, more of the rib, or it may be a portion also of the rib below, along with the intervening intercostal muscles, may have to be resected to enable the tuberculous lining of the abscess to be thoroughly dealt with. The intrathoracic fascia and the pleura are markedly thickened so that with ordinary care the pleural cavity need not be opened into. Before closing the wound sublimated iodoform-bismuth paste should be rubbed into the wall of the abscess. If the operation has been a limited one, and it be felt that no trace of disease has been left behind, the flap may be sutured back into position without drainage. If, on the other hand, the wound be of large size, it is well to introduce a drain for forty-eight hours or so, while in cases complicated with an abscess between the chest-wall and the pleura an iodoform-gauze tampon should be introduced for a week or so.

When the disease is situated at the costo-chondral junction of one of the lower ribs, the secondary abscess is in the neighbourhood of the lower margin of the chest, and not infrequently it gravitates downwards either between the lateral abdominal muscles external to the sheath of the rectus, or within the latter, between its posterior wall and the rectus muscle. When the abscess is situated within the sheath of the rectus, the pus collects as a rule behind the muscle in the first instance, and subsequently burrows through it. In a case of this kind a free longitudinal incision should be made into the sheath of the muscle, and after cleaning out and curetting the superficial portion of the abscess, the deeper portion should be laid open from end to end, by splitting the rectus and following the abscess upwards until its source from the diseased cartilage is reached. The diseased portion of the cartilage is then resected, a knife usually sufficing to divide it. The deep portion of the abscess should be dissected off the under surface of the rectus muscle as far as possible, and the floor of the abscess should be thoroughly curetted.

The same line of treatment is to be followed when the disease is

and then rubbed over the wall with the finger. The same mixture should be smeared over the wound before it is sutured. Most surgeons now dispense altogether with drainage. In many instances the abscess does not re-form and the wound remains permanently healed. In other cases the abscess re-forms, the wound and scar become tuberculous, and, ultimately, a sinus results. The latter, however, often closes in the course of a few months. If not, the curetting should be repeated, after which the cavity may either be stuffed for a time, or the sinus and scar may be excised and the wound completely closed. If a mixed infection has occurred, a rubber drain must be introduced.

While many surgeons are in favour of treating spinal abscesses by curetting followed by the introduction of iodoform, there are others who employ neither, but trust merely to evacuation and irrigation. The writer has treated many abscesses successfully by the latter more simple method. Many surgeons, again, instead of opening the abscess, prefer to empty it by aspiration through a large trocar, and to inject iodoform and glycerine.

After-treatment. The after-treatment is all-important. It consists in keeping the spine quiet with the patient constantly recumbent (as much as possible in the open air) for at least a year, and generally longer. The bed-frame introduced by Bradford is probably the most convenient apparatus for the purpose. Extension must be applied if there be any spastic condition or tendency to paraplegia.

OPERATIONS FOR TUBERCULOUS OSTEOMYELITIS OF THE RIBS

Operation. While spontaneous cure of the disease rarely occurs, operative treatment is almost invariably followed by recovery, provided the bone focus be completely removed. Recurrence, on the other hand, is very prone to occur if, after opening the abscess, the surgeon trusts simply to scraping the rib. The proper course to adopt is to resect the diseased portion of the rib, and care must be taken that the bone or cartilage is divided well beyond the disease The operative procedure in the case of a limited focus at the costo-chondral junction of one of the true ribs, with a secondary abscess under the pectoralis major, is carried out as follows: A horseshoe incision is made a little beyond the lower two-thirds of the circumference of the swelling, and a flap, consisting of skin and subcutaneous tissue, is dissected upwards off the pectoralis major. The fibres of this muscle are now divided along the circumference of the abscess down to its pyogenic wall, and the latter, along with the muscle, is then dissected off the chest-wall. By excising the

SECTION I

OPERATIONS FOR TUBERCULOUS AFFECTIONS OF THE BONES AND JOINTS

PART II

OPERATIONS FOR TUBERCULOUS AFFECTIONS OF THE JOINTS

BY

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situated in the abdominal wall external to the rectus. Here the deepest part of the abscess usually occupies the interval between the transversalis muscle and its fascia, the latter being considerably thickened to form the outer fibrous layer of the pyogenic membrane.

When the diseased focus is situated posterior to the costo-chondral junction, the abscess is situated under the serratus magnus, the external oblique, or the latissimus dorsi. In dealing with an abscess in any of these situations the operator should not hesitate to remove every particle of diseased muscle along with the abscess; if this be not done a tubercular sinus is almost certain to develop in the scar.

As pointed out by König, the operation for tuberculosis of a rib may be very troublesome when the disease is complicated with multiple sinuses which are both elongated and tortuous. Considerable patience and perseverance may have to be exercised before the disease can be satisfactorily removed. Not infrequently more than one operation will be necessary. In the female the mamma may have to be removed in order that the operation may be sufficiently radical.

When the abscess is situated in the axilla the surgeon must satisfy himself that there is no disease of the rib before deciding that caseous glands are alone responsible for the condition.

CHAPTER V

OPERATIONS FOR TUBERCULOUS DISEASE OF THE WRIST-JOINT

UNDER the heading tuberculous disease of the wrist-joint there are included a group of lesions which are met with either singly or in various combinations depending on the site of origin of the disease and on the direction and extent of its spread.

Fortunately conservative treatment gives comparatively good results in the early stage of tuberculous disease of the wrist-joint, and in view of the somewhat unsatisfactory functional results following excision, the former treatment should be given a fair trial. Should it fail, however, operative measures must be undertaken. If the disease be allowed to run on until the synovial sheaths and tendons become involved, and if sinuses and mixed infection be allowed to occur, the functional result following excision will be unsatisfactory, owing to deficient movement of the fingers.

Operation. The nature of the operative interference will of course depend on the extent of the disease. By a complete excision of the wrist is meant the removal of the entire carpus (with the exception of the pisiform and the hook of the unciform) along with the adjacent articular extremities of the radius, ulna, and metacarpals. If the disease be confined to the carpus, the lower ends of the bones of the forearm may be left, and the same may be said of the proximal ends of the metacarpal bones when the disease has begun in the wrist-joint proper. The rule in operating on a tuberculous wrist should be to remove all the disease, but at the same time to sacrifice no more bone than is absolutely necessary; the greater the amount of bone removed the more are the flexors and extensors of the fingers left unnecessarily long, and the more is their action weakened.

Although a tourniquet is not essential, it has the advantage of expediting the operation and enabling the surgeon to obtain a clear view of the anatomy of the parts, which is rather more complicated than in the case of the other joints. The tourniquet should be applied to the lower third of the upper arm. Instead of placing the limb across the patient's body it will be found much more convenient to have the forearm and hand supported on a separate table of small size. The operator

extensor digitorum communis and the extensor minimi digiti (digiti quinti proprius), while in the lower part of the wound the dorsal branch of the ulnar nerve is seen, and, if possible, avoided.

The wound is now deepened so as to divide the thin posterior ligament of the inferior radio-ulnar joint; below it the dorsal ligaments are separated subperiosteally from the back of the cuneiform (triquetral)

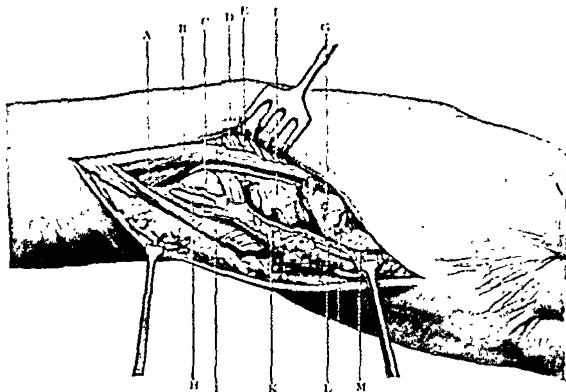


Fig. 27. Further Stage of the Operation shown in the previous Figure. The wound has been deepened, and the soft tissues, including the posterior ligaments and the periosteum, have been separated, exposing (from above downwards) the head of the ulna, the triangular fibro-cartilage, the cuneiform, unciform, and the base of the fifth metatarsal bone. The tendons of the extensor digitorum communis and the fibres of the extensor indicis are seen beneath the outer edge of the wound; the extensor minimi digiti and the extensor carpi ulnaris are seen at its inner edge. A, Extensor indicis; B, Extensor digitorum communis; C, Head of the ulna; D, Triangular cartilage; E, I, Posterior annular ligament; F, Cuneiform; G, Unciform; H, Extensor minimi digiti; K, Posterior ligament and periosteum; L, Tendon of the extensor minimi digiti; M, Base of the fifth metacarpal.

and unciform (hamate) bones, while still lower the tendon of the extensor carpi ulnaris is detached subperiosteally from the base of the fifth metacarpal bone. The inner flap, which contains the tendons of the extensor minimi digiti (digiti quinti proprius) and extensor carpi ulnaris along with the dorsal ligaments and periosteum, is now completely dissected off the head and styloid process of the ulna, the internal lateral

will find it an advantage to be comfortably seated while performing the operation.

Access to the diseased structures may be obtained either by a single dorsal incision (Langenbeck, Kocher) or by a dorso-radial incision, combined with an ulnar incision (Lister). Complete excision of the wrist by Lister's double incision has been dealt with by Mr. Burghard

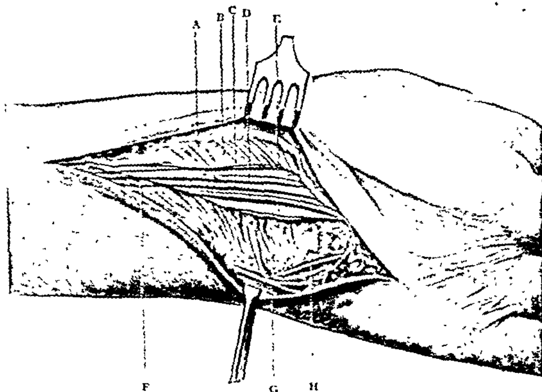


FIG. 26. EXCISION OF THE WRIST BY KOCHER'S SINGLE DORSO-ULNAR INCISION. The deep fascia and the posterior annular ligament have been divided, exposing the tendons of the extensor digitorum communis. The dorsal branch of the ulnar vein and nerve are seen at the inner border of the wrist. A, E, Posterior annular ligament; B, C, D, Extensor digitorum longus; F, Deep fascia; G, Posterior ulnar vein; H, Dorsal branch of ulnar vein.

in Vol. I, p. 561. This procedure should be reserved for cases in which the disease is especially advanced at the outer aspect of the wrist.

For the majority of cases the writer prefers the more conservative procedure recommended by Kocher. The incision, which is dorso-ulnar in position, is a modification of Langenbeck's straight dorsal incision; it passes from the middle of the fifth metacarpal bone to the middle of the back of the wrist, and thence for an equal distance up the middle of the back of the forearm, the entire incision measuring 4 to 5 inches.

After dividing the *integuments* and the *posterior annular ligament*, there is exposed, in the upper part of the wound, the inner edge of the

extensor digitorum communis and the extensor minimi digiti (digiti quinti proprius), while in the lower part of the wound the dorsal branch of the ulnar nerve is seen, and, if possible, avoided.

The wound is now deepened so as to divide the thin posterior ligament of the inferior radio-ulnar joint; below it the dorsal ligaments are separated subperiosteally from the back of the cuneiform (triquetral)

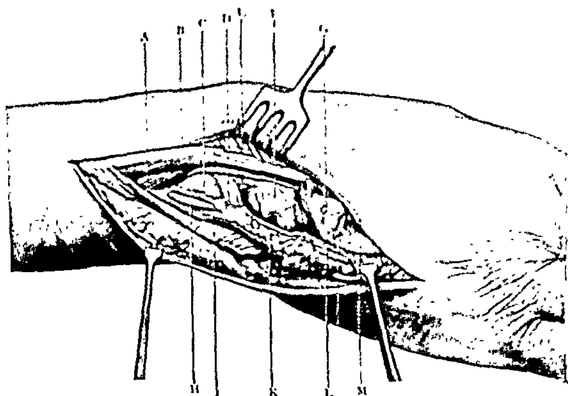


FIG. 27. FURTHER STAGE OF THE OPERATION SHOWN IN THE PREVIOUS FIGURE. The wound has been deepened, and the soft tissues, including the posterior ligaments and the periosteum, have been separated, exposing (from above downwards) the head of the ulna, the triangular fibro-cartilage, the cuneiform, unciform, and the base of the fifth metatarsal bone. The tendons of the extensor digitorum communis and the fibres of the extensor indicis are seen beneath the outer edge of the wound; the extensor minimi digiti and the extensor carpi ulnaris are seen at its inner edge. A, Extensor indicis; B, Extensor digitorum communis; C, Head of the ulna; D, Triangular cartilage; E, I, Posterior annular ligament; F, Cuneiform; G, Unciform; H, Extensor minimi digiti; K, Posterior ligament and periosteum; L, Tendon of the extensor minimi digiti; M, Base of the fifth metacarpal.

and unciform (hamate) bones, while still lower the tendon of the extensor carpi ulnaris is detached subperiosteally from the base of the fifth metacarpal bone. The inner flap, which contains the tendons of the extensor minimi digiti (digiti quinti proprius) and extensor carpi ulnaris along with the dorsal ligaments and periosteum, is now completely dissected off the head and styloid process of the ulna, the internal lateral

ligament being divided. Below the ulna the flap is separated subperiosteally from the palmar aspect of the cuneiform (triquetral) bone until the joint between it and the pisiform is reached; the latter is detached along with the insertion of the flexor carpi ulnaris. Further down, the flap, along with the insertion of the extensor carpi ulnaris,

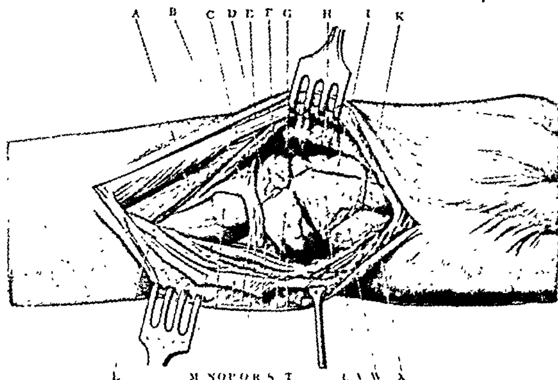


Fig. 28. Further Stage of the Operation shown in the previous Two Figures. The extensor tendons, along with the posterior ligaments and the periosteum, have been separated from the bones at the back of the wrist and retracted inwards. The soft parts at the ulnar edge have also been more completely separated. The tendon of the extensor minimi digiti and that of the extensor carpi ulnaris have each been freed from its groove and retracted forwards, along with the other soft parts, off the bones at the ulnar edge of the wrist. A, Extensor indicis; B, Radius; C, Extensor digitorum communis; D, Semilunar; E, O, Posterior annular ligament; F, H, Periosteal and dorsal ligaments; G, Scaphoid; I, Os magnum; K, Base of the third metacarpal; L, V, Extensor minimi digiti; M, Extensor carpi ulnaris; N, Head of the ulna; P, Triangular cartilage; Q, Styloid process; R, Internal lateral ligament, S, Cuneiform, T, Pisiform; U, Unciform; W, Base of the fifth metacarpal; X, Base of the fourth metacarpal.

is still further detached so as to expose the palmar aspect of the fifth metacarpal bone.

Attention is next directed to the dorsal flap, which is reflected outwards by detaching the posterior ligament of the wrist-joint from the lower end of the radius; the extensor tendons, along with the periosteum, are at the same time separated from the grooves on the back of the

bone. The separation is effected partly with the knife, and partly by a sharp rugine. Lower down, the latter instrument is used to separate the dorsal ligaments of the carpal and metacarpo-phalangeal joints, and care is taken to separate the insertions of the extensor carpi radialis brevis and longus subperiosteally. In this way all the bones at the back of the wrist, except the trapezoid (lesser multangular), the trapezium (greater multangular), and the bases of the first and second metacarpals, are laid bare.

By removing the cuneiform (triquetral) bone, room is obtained for the finger to feel and identify the hook of the unciform (hamate), which is either chiselled off or snipped off with small bone-forceps. The operator should keep close to the bone so as to avoid injuring the deep branch of the ulnar nerve, which winds round its inner aspect. The inner flexor tendons are now exposed, and pulled aside, after which the anterior ligament of the wrist and the anterior carpal and metacarpal ligaments are separated from the palmar aspect of the bones. The parietal layer of the common flexor sheath is so closely related to the anterior ligaments that it is generally removed with the latter, but no harm is done as long as the wound is aseptic.

The operator now returns to the dorsal aspect of the wrist, and, after retracting the extensor tendons well outwards, the separation of the posterior ligament of the wrist is carried as far outwards as the styloid process of the radius, the periosteum and the two radial extensors being lifted out of their groove. While this is being done, the hand is forcibly flexed and dislocated to the radial side, so that the thumb comes in contact with the radial border of the forearm and the extensor tendons become dislocated to the outer side of the lower end of the radius. By this manœuvre the wrist-joint proper is freely opened up and the carpal bones are projected more into the wound; in short, a very free arthrotomy has been obtained.

The operator is now able to ascertain the exact distribution of the disease and to decide to what extent the resection must be carried in order to remove it completely. The carpal bones, with the exception of the trapezium (greater multangular) and the pisiform, are removed, either collectively, or, which is preferable, individually, by grasping them with necrosis forceps and partly cutting and partly wrenching them away from the remaining ligamentous attachments. Some little difficulty may be experienced in freeing the tubercle of the scaphoid (navicular) from the external lateral ligament and the trapezium (greater multangular) from the trapezoid (lesser multangular) bone.

If the disease has extended to the joint between the trapezium (greater multangular) and the first metacarpal bone, the former must be resected

and the base of the latter removed, after separating the tendon of the extensor ossis metacarpi pollicis (abductor pollicis longus). For this purpose a short dorso-radial incision should be made to the outer side of and parallel to the tendon of the extensor secundi internodii pollicis (extensor pollicis longus). The radial artery and nerve are exposed and

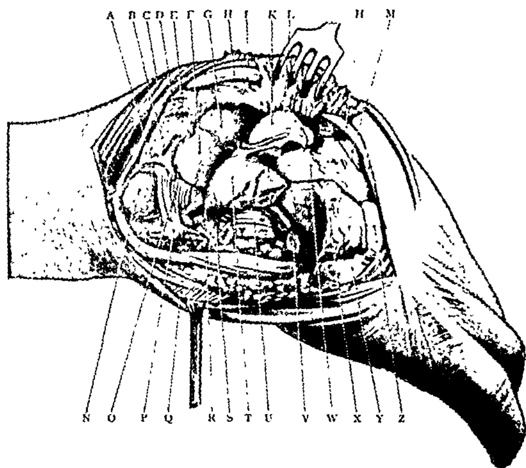


FIG. 29. FURTHER STAGE OF THE OPERATION SHOWN IN THE PREVIOUS THREE FIGURES. The cuneiform bone has been removed, and the pisiform and the hook of the unciform have been detached. The radio-carpal and intercarpal articulations have been opened up, and the hand has been flexed to the radial side. The two radial extensor tendons are seen at the outer side of the dorsum of the wrist, while the tendon of the extensor carpi ulnaris is seen at the inner side. In the floor of the wound are the flexor tendons. A, Groove for the extensor minimi digiti; B, Groove for the extensor digitorum communis and extensor indicis, C, Extensor indicis; D, Groove for the extensor pollicis longus; E, Dorsal radial tubercle; F, Radial articular surface for the semilunar; G, Radial articular surface for the scaphoid; H, Extensor carpi radialis brevior; I, Extensor carpi radialis longior; K, Scaphoid; L, Periosteal and dorsal ligaments; M, Base of the third metacarpal; N, Head of the ulna; O, Triangular cartilage; P, Styloid process; Q, Posterior annular ligament; R, Extensor carpi ulnaris; S, Anterior ligaments; T, Semilunar; U, Flexor tendons; V, Cut base of the hook of the unciform; W, Os magnum; X, Unciform; Y, Base of the fifth metacarpal; Z, Base of the fourth metacarpal.

drawn aside along with the soft parts before proceeding to remove the osseous disease.

The carpo-metacarpal joint, on account of its possessing a separate synovial membrane, is often free from disease, and when this is the case the trapezium (greater multangular) may generally be left, with the result that the movements of the thumb are not interfered with.

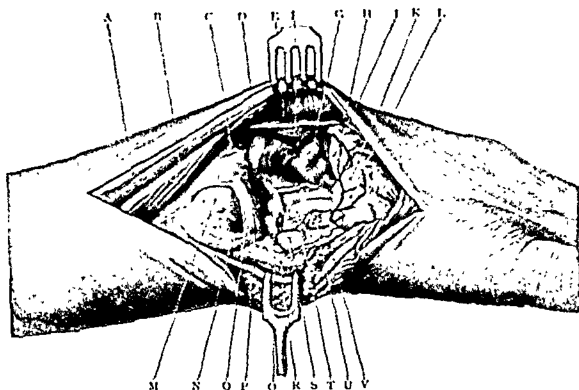


FIG. 30. FURTHER STAGE OF THE OPERATION SHOWN IN THE PREVIOUS FOUR FIGURES. All the carpal bones have been removed except the trapezium. The articular surfaces of the third, fourth, and fifth metacarpals are seen at the lower end of the wound. In the floor of the wound are the deep flexor tendons, and internal to them are seen the articular surfaces of the pisiform bone and the detached hook of the unciform. A, Extensor digitorum communis; B, Extensor indicis; C, Radius; D, Periosteal and dorsal ligaments; E, Extensor carpi radialis brevior; F, Extensor carpi radialis longior; G, Trapezium; H, Styloid process of the third metacarpal; I, Base of the third metacarpal; K, Base of the fourth metacarpal; L, Base of the fifth metacarpal; M, Head of the ulna; N, Styloid process; O, Triangular cartilage; P, Extensor carpi ulnaris; Q, Cut edge of the anterior ligaments; R, Dorsal ligaments; S, Pisiform; T, Flexor tendons; U, Cut base of the hook of the unciform; V, Extensor minimi digiti.

Unless the disease demands it, the bases of the metacarpal bones should not be sawn off; if on the other hand it be necessary to remove them, the periosteal connexions of the two radial extensors and of the radial flexor should be preserved as far as possible. If free from disease, the articular extremities of the radius and ulna along with the triangular

fibro-cartilage should also be preserved. Should the disease have commenced in the wrist-joint proper it will, of course, be necessary to remove the lower ends of these bones along with the interarticular fibro-cartilage.

In removing the distal ends of the bones of the forearm and the *proximal ends of the metacarpal bones, Kocher recommends that the* saw should be applied so as to produce convex surfaces on a transverse axis, with the object of facilitating flexion and extension.



FIG. 31. EXTENSIVE TUBERCULOUS DISEASE OF THE WRIST. Skiagram from a female aged thirty-two. The carpo-metacarpal (with the exception of the joint between the first metacarpal and the trapezium) and wrist-joint proper were diseased along with the intercarpal joints. (*By Dr. E. Price.*)

On the removal of the carpal bones, the floor of the wound is seen to be occupied by the ligamentous structures and the remains of the periosteum separated from their palmar aspects. As a rule these structures are so invaded with tubercle that their removal is called for, along with the parietal layer of the common flexor sheath. The close relationship of the carpus to the parietal layer of the palmar sheath accounts for the frequency with which the latter is invaded by the disease. When this has occurred, the flexor tendons must be lifted well out of their tunnel, and the whole of the diseased sheath carefully dissected

away. It is advisable to operate before the palmar sheath has become involved, because the adhesions which follow its removal seriously interfere with the patient's ability to flex the fingers.

Cases complicated with abscesses or sinuses must be treated on the general principles already mentioned in dealing with the other joints. Fortunately the sinus is generally situated either at the radial or ulnar side of the wrist, so that in excising it the ellipse may be included in



FIG. 32. RESULT OF EXCISION OF THE WRIST. Skiagram taken six months after excision by Kocher's single dorso-ulnar incision, from the same case as the previous figure. Note the presence of the pisiform, the hook of the unciform, and the trapezium, also the healed condition of sawn surfaces of bones. The patient had good use of the fingers and especially of the thumb. *(By Dr. E. Price.)*

the main incision. Before closing the wound sublimated iodoform-bismuth paste should be rubbed into the raw surfaces. Drainage may be secured by pulling a rubber tube or strip of gauze through a button-hole opening made by cutting down on forceps projected from the main wound to the palmar aspect of the wrist just internal to the median nerve. The advantage of the drain is that it allows the rest of the wound to be closely stitched, and so prevents any tendency to prolapse of the extensor tendons.

The advantages which Kocher claims for his operation are: (1) That the incision avoids the dorsal branch of the ulnar nerve, whereas the radial nerve is injured by the dorso-radial incision. (2) The detachment of the tendon of the extensor carpi ulnaris has not the same disadvantage as has division of the radial extensors, because the ulnar extensor has much less share in dorsiflexing the hand than the radial extensors. The extensor carpi ulnaris assists mainly in producing ulnar flexion, a displacement which, due partly to the weight of the hand and partly to cicatricial contraction, is peculiarly liable to occur after excision. The division of this tendon is, therefore, rather beneficial than otherwise. (3) With the dorso-ulnar incision the extensor tendons have less tendency to protrude from the wound than in the dorso-radial incision.

After-treatment. The important point to attend to in the after-treatment is to see that the hand is maintained in the dorsiflexed position with the thumb and fingers left free. For this purpose the operator may make use of Lister's anterior splint, which is thickened opposite the metacarpal region by means of a cork pad. In the child the writer is in the habit of using simply an anterior strip of aluminium, which can easily be bent backwards opposite the wrist so as to bring the hand into the dorsiflexed position. The advantage of such a splint is that it can be sterilized and applied inside the bandage which fixes on the dressing.

The chief drawback to excision of the wrist from the functional point of view is the difficulty the patient experiences in acquiring sufficient power of flexing the fingers. This difficulty is due partly to the flexor tendons being too long after the bones have been removed, and partly to adhesion of the tendons. The former factor is minimized by allowing the parts to consolidate with the hand dorsiflexed so as to put the flexor tendons as much on the stretch as possible, while the latter cause is combated by beginning massage and movement, both passive and active, as soon as the wound is healed.

CHAPTER VI

OPERATION FOR TUBERCULOUS DISEASE OF THE ELBOW-JOINT

Operation. Great difference of opinion still exists as to the relative merits of conservative and radical treatment in dealing with tuberculous disease of the elbow-joint.

In the early stage of the disease a skiagram should always be taken before giving a definite opinion as to whether conservative measures (including iodoform injections and Bier's congestion treatment) should be tried, or whether operation should be recommended. If a bone focus be revealed, the writer prefers to proceed to operation at once. If, on the other hand, there is reason to believe that the disease is purely synovial, conservative measures may be employed, but should no improvement manifest itself within a few weeks, radical treatment should be advised.

When operating in the early stage of the disease, instead of proceeding to do a stereotyped excision, the first step in the operation should be a free arthrotomy. For this purpose the writer prefers the external J-shaped incision of Kocher. This gives a good exposure of the interior of the joint and at the same time inflicts the minimum of damage to the muscles and their nerve-supply. The upper part of the incision, which begins about two inches above the external condyle, is carried downwards along the back of the external supracondyloid ridge through the fleshy fibres of the triceps external to its tendon ; the middle part opens into the posterior aspect of the radio-humeral joint by dividing the posterior part of the external lateral and orbicular (annular) ligaments in the interval between the tendon of origin of the anconeus and the common extensor tendon; the lower part of the incision is continued downwards along the intermuscular space between the fleshy fibres of the anconeus and the extensor carpi ulnaris, and ends by curving inwards to reach the posterior border of the ulna about two inches below the tip of the olecranon.

The inner flap, including the insertion of the triceps and practically the whole of the anconeus, is detached subperiosteally from the back of the humerus and olecranon, partly with the knife and partly with a sharp rugine. Care is taken to preserve the continuity between the insertion of the triceps and the periosteum of the ulna below it. Kocher attaches

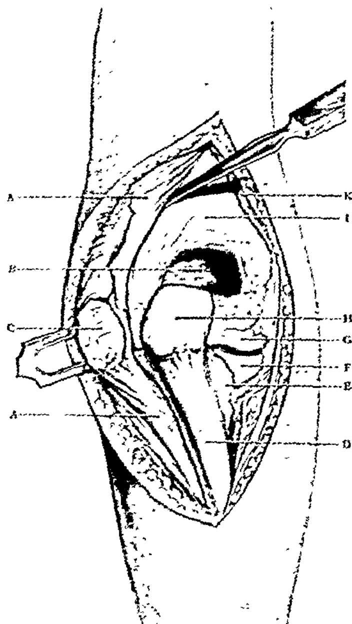


FIG. 33. EXCISION OF THE ELBOW BY KOCHER'S EXTERNAL, SLIGHTLY J-SHAPED INCISION. The extensor flap, consisting of the tendon of the triceps, a layer of cartilage detached from the olecranon and, beneath it, of the anconeus, has been reflected outwards subperiosteally off the lower end of the humerus and the upper part of the ulna. The orbicular (annular) ligament has been divided, exposing the head of the radius. A, A, Periosteum; B, Olecranon fossa; C, Insertion of the triceps; D, Ulna; E, Orbicular ligament; F, Radius; G, Capitellum; H, Olecranon; I, Humerus, K, Triceps.

considerable importance to the preservation of the anconeus along with the branch of the musculo-spiral (radial) nerve which supplies it. This nerve, which descends vertically in the substance of the inner head of the triceps, enters the deep surface of the anconeus by passing beneath its upper border midway between the external condyle and the outer edge of the olecranon. After detaching the flap from the olecranon, the next step consists in reflecting it, along with the ulnar nerve, off the internal condyle. In doing this the thumb of the left hand retracts the flap, while the nail protects the nerve from the edge of the knife, which should be kept close to the bone. Should there be considerable swelling and thickening of the soft parts the separation of the flap is facilitated by turning back the skin and subcutaneous tissue before separating the subjacent muscular and aponeurotic tissues. Owing to the position of the incision, the reflection of

the soft tissues off the external condyle and the head of the radius is a comparatively simple matter. The common tendons of origin of the flexor and extensor muscles, along with the upper attachment of the lateral ligaments, should, if possible, be preserved intact by detaching them either subperiosteally or along with a thin shell of bone. In the child the separation is easily effected by paring off a portion of the cartilaginous epicondyles along with the origins of the muscles; in the adult a strong sharp rugine should be used.

After the flaps have been completely dissected off the condyles, the assistant fully flexes the elbow and projects the lower end of the humerus well into the wound, so that the surgeon may clear it preparatory to applying the saw. Before doing so, however, the operator should carefully examine the olecranon fossa to ascertain the presence or absence of a small perforation leading into it from a limited bone focus higher up. If there be no visible focus of disease in the humerus, it should be sawn across at the level of the upper part of the epicondyles, and if no disease be detected on the raw surface, the sharp corners of the remaining portions of the epicondyles should be rounded off. It is well also to clip away the thin layer of bone forming the remains of the olecranon fossa, so as to leave a slightly crescentic extremity; this is done with the object of diminishing lateral movement subsequently. If, on the other hand, a well circumscribed focus of disease be revealed on the sawn surface, thorough curetting will generally suffice; if the focus be more diffuse it is safer to separate the periosteum and saw the bone at a higher level, well clear of the disease. In some cases it is impossible to remove all the disease without dividing the bone through the lower part of the medullary cavity. Fig. 5 is taken from a case in which the lower third of the humerus had to be resected subperiosteally at the same time that the elbow was excised. The periosteum was incised in the line of the original incision, which was prolonged further up the arm. The periosteal tube is closed by the same sutures which unite the triceps to the supinator longus (brachio-radialis) and the extensor carpi radialis longior.

Having dealt with the humerus, the operator next proceeds to clear the upper ends of the radius and ulna, the assistant meanwhile fully flexing the elbow and thrusting the bones of the forearm as far up into the wound as possible. To free the radius, the orbicular (annular) ligament should be completely removed, after which the neck of the bone is divided well below the head. The advantage of removing the greater part of the neck of the radius is twofold: (1) It ensures complete removal of the collar of diseased synovial membrane which occupies the recessus sacciformis—a diverticulum of the synovial cavity which surrounds the upper part of the neck of the radius below the level of the orbicular ligament. (2) It diminishes

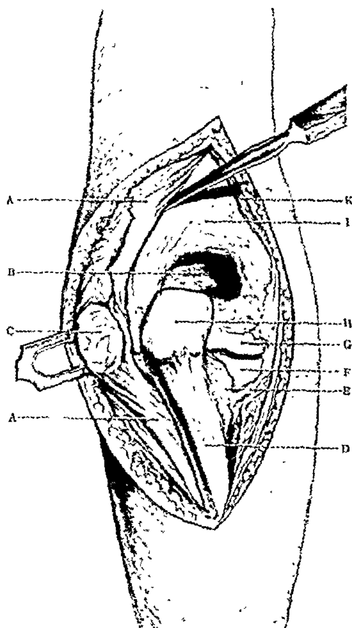


FIG. 33. EXCISION OF THE ELBOW BY KOCHER'S EXTERNAL, SLIGHTLY J-SHAPED INCISION. The extensor flap, consisting of the tendon of the triceps, a layer of cartilage detached from the olecranon, and, beneath it, of the anconeus, has been reflected outwards subperiosteally off the lower end of the humerus and the upper part of the ulna. The orbicular (annular) ligament has been divided, exposing the head of the radius. A, A, Periosteum, B, Olecranon fossa; C, Insertion of the triceps; D, Ulna; E, Orbicular ligament; F, Radius, G, Capitellum; H, Olecranon; I, Humerus; K, Triceps.

considerable importance to the preservation of the anconeus along with the branch of the musculo-spiral (radial) nerve which supplies it. This nerve, which descends vertically in the substance of the inner head of the triceps, enters the deep surface of the anconeus by passing beneath its upper border midway between the external condyle and the outer edge of the olecranon. After detaching the flap from the olecranon, the next step consists in reflecting it, along with the ulnar nerve, off the internal condyle. In doing this the thumb of the left hand retracts the flap, while the nail protects the nerve from the edge of the knife, which should be kept close to the bone. Should there be considerable swelling and thickening of the soft parts the separation of the flap is facilitated by turning back the skin and subcutaneous tissue before separating the subjacent muscular and aponeurotic tissues. Owing to the position of the incision, the reflection of

supinator brevis may be stitched over the stump of the bone. If the disease has perforated the thin part of the capsule below the orbicular ligament and burrowed downwards between the two bones, it may be followed up and removed either at this stage or after the ulna has been dealt with.

If there be no primary focus in the upper end of the ulna, the plan recommended by Kocher should be adopted, namely, to saw off the articular surface so as to leave a concave surface. For this purpose a fine bow saw is used; the section is made from before backwards. Before

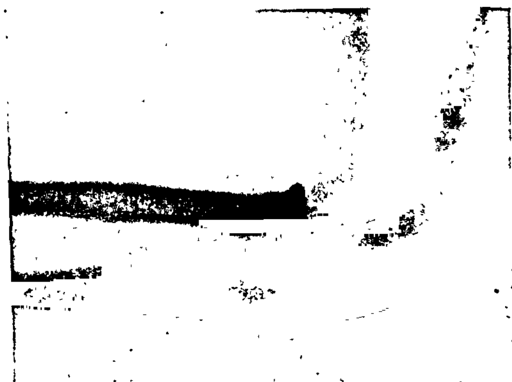


FIG. 35. SKIAGRAM OF THE ELBOW OF A CHILD AGED SIX YEARS. Shows tuberculous foci in the upper end of the ulna. (*By Dr. E. Price.*)

applying the saw, the anterior ligament, along with the insertion of the brachialis anticus, should be slightly separated subperiosteally from the front of the coronoid process.

If, on the other hand, the joint has become involved secondary to a primary focus in the olecranon, this process should be removed as soon as the extensor flap has been separated from it. By this means the joint is at once opened into and free access is obtained for the clearing and removal of the lower end of the humerus. After this has been done the operator returns to the bones of the forearm and completes the removal of their upper extremities, the ulna being sawn off below the disease.

When, as is not infrequently the case in young children, the disease

the risk of firm union between the radius and the humerus, and thereby helps to preserve the movements of pronation and supination. To ensure still further the preservation of these movements, some of the fibres of the

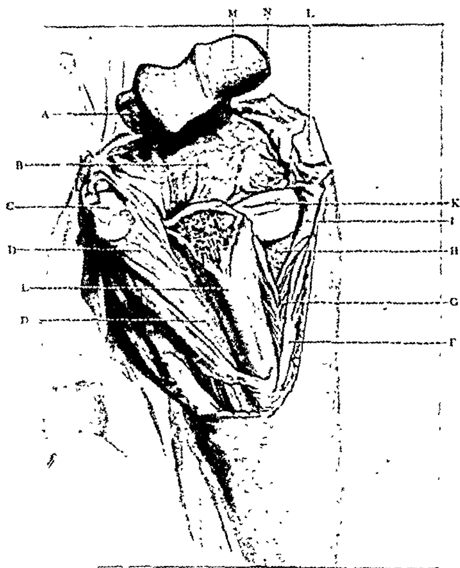


FIG. 34. FURTHER STAGE OF EXCISION OF THE ELBOW BY KOCHER'S INCISION. Both flaps, along with a portion of each epicondyle, have been completely reflected off the condyles, and the lower end of the humerus has been cleared anteriorly and posteriorly. The elbow is fully flexed, causing the humerus to protrude. The olecranon has been snipped off with bone-forceps and the periosteum stripped from the portion of the ulna below it. The orbicular ligament has been divided and reflected outwards, exposing the head and neck of the radius. The floor of the wound is occupied by the thin anterior ligament covered by the synovial membrane. A, Internal condyle; B, Anterior ligament, C, Insertion of the triceps; D, D, Periosteum; E, Ulna; F, Extensor carpi ulnaris; G, Supinator brevis; H, Neck of the radius; I, Orbicular ligament; K, Radius; L, External epicondyle; M, Capitellum; N, External condyle.

should be excised whenever possible. When situated towards the outer aspect of the joint they may be included in an ellipse which is made to form a part of Kocher's incision, while if they are situated upon the inner aspect of the joint, the openings made after excising them may be taken advantage of for drainage.

After the disease is all removed, the wound is sutured in two layers. The deeper sutures (interrupted catgut) unite the following muscles from above downwards: (1) The outer edge of the triceps to the external intermuscular septum, and to the muscles arising from it, namely, the supinator longus and the extensor carpi radialis longior; (2) the tendon of origin and outer margin of the anconeus to the common extensor tendon and to the inner edge of the extensor carpi ulnaris. The superficial sutures, consisting of silkworm-gut and intermediate horsehair, unite the skin and subcutaneous tissue. In the absence of mixed infection, drainage is often unnecessary, especially if no tourniquet be used at the operation.

After-treatment. Considerable difference of opinion exists among surgeons as to the best method of carrying out the after-treatment of excision of the elbow. Some prefer to place the elbow in the extended position for two or three weeks before flexing it, while others place it in the flexed position at the outset; some begin passive movement as soon as the wound is healed, while others wait for three or four weeks; some avoid passive movement if possible, but take special steps to encourage active movement. The fact, however, is that no single line of after-treatment is suitable for all cases. Much depends on the age of the patient, on the amount of bone removed, and on the extent to which the peri-articular tissues and muscles have been interfered with. The ideal result to be arrived at is a freely movable, and at the same time a muscularly strong joint, without, however, any preternatural movement.

In the young child, in a case of average severity, the writer is in the habit of keeping the forearm extended and somewhat supinated for the first fortnight or so, complete rest being ensured by bandaging the limb to the side of the chest, which is thus converted into a splint. During the next fortnight the elbow is kept alternately flexed and extended for periods of forty-eight hours, the flexion being maintained by means of a rectangular aluminium splint. At the end of a month the arm is merely supported in a sling, and the child is encouraged to begin to use it. Should the patient refuse to do so, the opposite arm should be bandaged to the chest so as to encourage the child to play with its toys with the affected limb. If the disease has been more extensive than usual, the chances of a flail joint will be lessened if the limb be placed in the flexed position from the outset.

As a rule the after-treatment in the adult consists in keeping the

involves the upper part of the shaft of the ulna as well as the olecranon (Fig. 35), the bones of the forearm must be resected to a still lower level. After splitting the periosteum longitudinally the ulna may be shelled out, either from above downwards after opening into the joint, or from below upwards before the joint is opened into. The radius, whether diseased or not, should be divided at the same level as the ulna, care being taken not to injure either the biceps tendon or the posterior interosseous (deep radial) nerve. The edges of the split periosteum are united with buried catgut sutures before closing the skin wound.

Having dealt with the ends of the bones, attention is next directed to the disease in the soft parts. When the tuberculous mischief is still confined within the capsule, this is a very simple matter, as the arrangement of the synovial membrane is comparatively simple. The whole of the posterior ligament and the synovial pouch beneath the triceps is removed to a level well above the olecranon fossa. At the floor of the wound is the diseased synovial membrane covering the anterior ligament, in front of which is the brachialis anticus muscle, which excludes the brachial artery from the immediate field of operation. As a rule it will be found necessary to dissect the thin anterior ligament off the brachialis anticus along with the synovial membrane. Occasionally, however, the disease is so limited to the synovial membrane that the latter may be clipped or scraped away, leaving the ligament intact. As already indicated, it is important to make sure that no diseased synovial membrane is left in the recessus sacciformis which surrounds the neck of the radius below the orbicular (annular) ligament.

In more advanced cases, where the disease has extended through the capsule, involved the peri-articular structures, infiltrated the muscles around the joint, and, it may be, burrowed up the arm and down the forearm, the removal of all the infected tissues is a matter of considerable difficulty. Neither time nor perseverance should be spared in following up and removing them, as freedom from recurrence, and, which is more important, the avoidance of subsequent amputation, depend very largely upon the thoroughness with which this part of the operation is carried out. Every particle of tuberculous capsule and peri-articular tissue should be removed, no matter how extensive the infiltration, and all caseous pockets and abscesses should, whenever possible, be excised rather than curetted. If the ulnar nerve be in danger, it is better to ascertain its whereabouts by exposing it in the first instance above or below the disease, and then following it through the infiltrated tissue which surrounds it. The musculo-spiral (radial) and posterior interosseous (deep radial) nerves are less liable to be involved.

The presence of sinuses still further complicates the operation. They

CHAPTER VII

TUBERCULOUS DISEASE OF THE SHOULDER-JOINT

Except when associated with advanced pulmonary tuberculosis, conservative treatment is not to be recommended in tuberculous disease of this joint, as it almost invariably results in ankylosis, a condition attended with great disability. By excision, on the other hand—especially if undertaken before the stage of abscess formation and involvement of the peri-articular structures—an excellent result with comparatively free movement at the shoulder may generally be looked for.

When the disease has begun in the upper end of the humerus, it is usual to excise the joint by the anterior method. When, however, the disease involves more especially the glenoid cavity, or when it is more advanced and diffused throughout the joint, Kocher prefers to resect the joint from behind.

With regard to the advantages of the posterior route, this author writes as follows: 'When the head has been thoroughly cleared, and especially if it be excised, an excellent view of the glenoid is obtained, much better than is possible by the anterior incision; and as it is most important to remove all the infected tissues in tuberculous disease, this complete exposure of all parts of the joint is the great advantage of the method. Moreover, this free exposure is obtained without interfering with the function of the deltoid or other muscles of the shoulder. Yet another advantage over the anterior method is, that when the disease in the head is limited or absent, only the posterior muscles require to be separated, while the anterior part of the capsule, the coraco-humeral band, and the subscapularis muscle are preserved intact, and in this way there is no tendency of the head of the bone to be displaced upwards towards the coracoid, which so frequently occurs as the result of the anterior operation.'

Both the anterior and posterior operations have been fully described by Mr. Burghard (Vol. I, pp. 582–7). It will suffice therefore in this article merely to draw attention to a few points regarding the operation as performed for tuberculous disease.

When the disease in the joint is secondary to a focus in the upper end of the humerus, the muscles attached to the tuberosities must be

elbow extended and somewhat supinated for the first two or three weeks, after which time the limb is massaged and active movement encouraged. If there be a tendency to stiffness, passive movements must be persevered with. Pronation and supination may be begun almost from the first. If the joint shows signs of becoming flail, the limb should be fixed in plaster of Paris in the flexed position for some weeks. If, on the other hand, it be evident that ankylosis is going to result, the patient's occupation must be taken into account in deciding as to the position in which the elbow is allowed to become stiff. In well-to-do patients, and in almost all females, the limb should be fixed at an angle of about 70° or 75°, while in those whose employment entails the carrying and lifting of heavy objects, the elbow should be fixed at an obtuse angle. In both instances the forearm should be in the mid-position between pronation and supination. Kocher points out that on no account should the forearm be placed across the front of the chest in the flexed and adducted position. He applies a splint which maintains the forearm in the supinated and vertical position, so that the ends of the radius and ulna may rest in the coronal plane against the lower end of the humerus. He begins active movement after a few days, and maintains that plaster bandages are not needed.

Results. Of the forty-six primary excisions of the elbow which the writer has done during the last ten years, the disease was found to be primarily synovial in 29%. In only one case was the radius primarily affected, in the others the primary disease occurred with almost equal frequency in the humerus and ulna. Of the thirty-one patients subsequently traced, one died of broncho-pneumonia four days after the second elbow was resected, five of general tuberculosis, and two of an intercurrent disease. Information as regards the functional after-result could only be obtained in sixteen cases. Of these eight had a strong freely movable joint; in six there was lateral movement in addition to flexion and extension, and in some of these there was a tendency to a flail joint. In one the limb was ankylosed at a right angle with full pronation and supination, and in another at 145°. In a little more than half the cases the child was under five years of age at the time of operation. 40% of the cases were complicated with either an abscess or a sinus. In children a certain amount of shortening is inevitable, as all the epiphyseal cartilages about the elbow are removed. In the cases operated on, the shortening of the upper arm varied from nothing to 2½ inches, and in the forearm from 1 to 4 inches. Fortunately growth takes place to a less extent from the cubital epiphyses than from those of the shoulder and wrist.

detached from its insertion. Great care must be taken not to injure the circumflex nerve.

An abscess or sinus, the result of disease of the scapula, is generally found either in the axilla or in the region of the posterior border of the deltoid; it can be got at by prolonging downwards Kocher's posterior incision.

In the presence of sinuses and mixed infection, the wound should be only partially closed, plenty of room being left for the introduction of iodoform gauze. If necessary a drainage tube may be passed into the anterior wound and brought out through a button-hole opening opposite the posterior border of the deltoid. Even in the absence of infection, a rubber tube should be introduced from the lower part of the anterior incision down to, but not into, the sutured capsule.

In applying the dressing, a pad is placed in the axilla to prevent the upper end of the humerus being displaced inwards. The dressing is secured in position by a bandage which fixes the upper arm to the trunk, the forearm being lightly supported in a sling.

Cheyne and Burghard (*Manual of Surgical Treatment*, Part IV, p. 254) recommend the following after-treatment: 'As soon as the wound has healed, the arm may be fixed in proper position by a starch or water-glass bandage, and, after two weeks more, passive movement may be begun; the period at which this passive movement should be employed depends largely upon the amount of bone removed; if the whole of the upper end of the bone has been removed and the rotators divided, as was done in the old operation, the elbow should be supported and the arm fixed for four or five weeks, as otherwise a very lax joint is likely to result; if, on the other hand, the operation we have described is sufficient, passive movement should be begun after a fortnight. Special attention must be paid to preserving rotation, which is the movement most likely to be lost; abduction should also be carefully attended to. The axillary pad and the wrist-sling should be continued for six or eight weeks.'

freely separated. The capsule is slit up from the bicipital groove as far as the glenoid, and the tendon itself is freed and displaced to the inner side of the inner tuberosity. The capsule, along with the rotator muscles, is then separated subperiosteally from the tuberosities by a strong rugine or, if preferred, a thin layer of bone may be detached along with the periosteum. When a limited focus is situated in the great tuberosity, thorough curetting followed by the introduction of sublimated iodoform-bismuth paste will generally suffice. If, however, the focus in the humerus be more diffuse, the periosteum must be still further separated and the bone sawn across immediately below the disease. Care must be taken not to wound the circumflex vessels, and more particularly the circumflex nerve. The saw is applied parallel to the anatomical neck.

In a case of primary synovial disease, there is no necessity to remove more than the articular surface of the humerus. The bone is sawn obliquely along the line of the anatomical neck, and the sharp edge which is left is carefully clipped away with bone-forceps curved on the flat, so as to prevent injurious pressure on the axillary artery.

If the glenoid cartilage be diseased, or replaced by a carious surface, a thin slice of the bone must be removed, while if there be a primary focus in the neck of the scapula, the origin of the long head of the triceps must be separated subperiosteally, and still more bone removed. It is in these cases that the posterior route recommended by Kocher is specially advantageous.

With regard to the soft parts, in order to obtain sufficient access for the removal of all the synovial membrane, it is important to lay open the capsule as widely as possible; hence the importance of carrying the incision along the line of the biceps tendon right up to the apex of the glenoid. Transverse incisions into the capsule should be avoided, if possible, but any part of the ligament which is itself infiltrated with tubercle should be clipped away. Fortunately the capsule is so redundant that the gap which is left in it can generally be closed with catgut sutures. Care must be taken to remove all diseased synovial membrane around the biceps tendon. If the disease has invaded the bursa beneath the deltoid, the anterior part of this muscle should be divided close to the clavicle, so that, with the upper arm abducted (to relax the muscle), it may be everted as well as retracted. If the bursa beneath the subscapularis be involved it also must be dissected away.

All suppurating pockets and sinuses must be carefully followed up, and, if possible, dissected out. It is not uncommon to find a sinus extending down the upper arm from the bicipital groove. To get at this, the original anterior incision must be prolonged downwards, and the upper part of the tendon of the pectoralis major may have to be

inner extending from the middle of the first metatarsal bone to the neck of the astragalus (talus), the outer from the middle of the fifth metatarsal to the outer aspect of the anterior process of the os calcis (calcaneus). These incisions should be carried down to the bone except in the case of the posterior extremity of the inner incision, which should be kept superficial so as to avoid opening either into the ankle or the astragalo-scaphoid (talo-navicular) joint.

After detaching the tibialis anticus (anterior) from its insertion, the extensor tendons, along with the vessels and nerves, are separated from



FIG. 36. TUBERCULOUS DISEASE OF THE ANTERIOR TARSUS. Skiagram taken before operation (anterior tarsectomy). (*By Dr. E. Price.*)

within outwards from the ligamentous structures on the dorsum; the dorsalis pedis artery is divided close to where it passes through the first interosseous space. Next, after freeing and retracting the upper border of the abductor hallucis muscle, the tendon of the tibialis posticus (posterior) is detached from its insertion into the tuberosity of the scaphoid (navicular), and the dissection is then continued as far into the sole of the foot as possible, care being taken to keep close to the bones.

The patient is now placed in the semi-prone position so as to give more comfortable access to the outer side of the foot.

The external incision passes down to the bones between the tendons of the peroneus brevis and tertius; it divides the outer attachment of the lower anterior annular (cruciate) ligament and some of the fleshy

CHAPTER VIII

OPERATIONS FOR TUBERCULOUS DISEASE OF THE FOOT AND ANKLE

OPERATIONS FOR TUBERCULOUS DISEASE OF THE TARSO-METATARSAL JOINTS

THE disease is often secondary to a focus in the base of one of the metatarsal bones. Of the three synovial cavities connected with the tarso-metatarsal articulations, the inner is confined to the joint between the first metatarsal and the internal (first) cuneiform, the outer to the articulation between the fourth and fifth metatarsal and the cuboid. When the disease involves either of these synovial cavities the choice of treatment will lie, according to the extent of the disease, between a local excision and amputation of the involved digit or digits along with the adjacent tarsal bone.

To excise the joint between the base of the first metatarsal and the internal cuneiform, a semilunar flap is made to the inner side of the long extensor tendon, which is drawn aside. The tendon of insertion of the tibialis anticus (anterior) is either divided close to the bone, or if possible separated subperiosteally. The base of the first metatarsal is sawn across, while the internal (first) cuneiform is either chiselled across, or removed entirely, according to the extent of the disease. The bones are then grasped with forceps and either wrenched or cut away from the tendon of the peroneus longus.

The joint between the fourth and fifth metatarsal and the cuboid is excised in a similar manner to the above, but with the convexity of the flap directed outwards. The tendons of the peroneus brevis and tertius are detached from their insertions, while that of the longus is preserved by freeing it from the groove on the under surface of the cuboid. If the disease has commenced in the cuboid, the whole of it must be excised.

COMPLETE ANTERIOR TARSECTOMY

When the disease involves the tarso-metatarsal and anterior tarsal regions more extensively, a complete anterior tarsectomy should be performed. This operation, introduced by P. H. Watson in 1874, is performed as follows: Two *long dorso-lateral incisions are made, the*

reflecting the soft parts, together with the periosteum, off the bone in the form of a flap. The part of the cortex of the bone superficial to the focus is then chiselled away and the disease in the interior removed by gouging, which should extend well into the surrounding healthy bone. If the focus has given rise to local thickening at any part of the bone, the incision should be so planned as to expose that particular region. In dissecting a flap off the outer aspect of the bone the convexity of the incision should reach downwards well below the peroneal tendons, and these, along with the subjacent periosteum, should be dissected up along with the flap. In other cases a similar flap will have to be dissected up from the inner aspect of the heel, in which case care must be taken to avoid injuring the posterior tibial vessels and nerves or their plantar divisions.



FIG. 37. A CASEOUS TUBERCULOUS FOCUS IN THE OS CALCIS. Skiagram from a child aged two years. Note the sequestrum in the centre of the tuberculous focus. (*By Dr. E. Price.*)

When the disease is more diffuse, the best plan is to make a horseshoe incision a little above the borders of the heel opposite the insertion of the tendo Achillis. Externally the incision may extend forwards as far as the base of the fifth metatarsal bone, while internally it should end a little behind the bifurcation of the posterior tibial vessels about a finger's breadth from the internal malleolus. In the adult, if the whole of the os calcis is to be removed, a second incision must be carried from the horizontal incision vertically upwards along the outer edge of the tendo Achillis for an inch or more. The details of the operation have been described by Mr. Burghard (Vol. I, p. 602). When the operation is being performed for tuberculous disease, however, it is important to remove the bone as far as possible subperiosteally.

fibres of the extensor brevis digitorum. After detaching the insertion of the peroneus tertius from the base of the fifth metatarsal bone, the extensor tendons are separated from the outer side of the dorsum of the foot until the inner wound is reached; the separation is continued in an upward and downward direction until the bridge of soft tissues can be freely raised up from the bones. The soft structures are similarly separated from the plantar aspects of the bones, but before doing so the tendon of the peroneus brevis is detached from the prominent base of the fifth metatarsal and the tendon of the peroneus longus is freed from the groove on the under surface of the cuboid. The difficulty in separating the soft parts on the plantar aspect (due to the concavity formed by the transverse ridge of the skeleton of the foot) is to some extent diminished by snipping off the projecting base of the fifth metatarsal bone.

The remaining metatarsal bones are divided a little below their bases by a keyhole saw applied from the dorsum; the bridge of soft parts is meanwhile retracted well upwards. Posteriorly the saw is carried through either the scaphoid (navicular) and the cuboid bones, or further back through the head of the astragalus (talus) and the anterior process of the os calcis (calcaneus), according to the extent of the disease. Free drainage is provided for by passing through the tunnel one large or two smaller rubber tubes rolled up in a strip of iodoform gauze.

After-treatment. The chief point to attend to in the after-treatment is to keep the parts at rest with the foot maintained at a right angle. This is readily done by applying to the sole and lateral aspects of the limb a stirrup splint cut out of a sheet of aluminium.

By this operation the foot is of course considerably shortened, but if the tendons inserted into the metatarsal bones are separated as far as possible subperiosteally, the functional result is excellent.

OPERATIONS FOR TUBERCULOUS DISEASE OF THE OS CALCIS

Indications. A primary focus of tubercle is more frequently met with in the os calcis than in any other bone of the tarsus. It occurs quite frequently in young children and is not uncommon in adults. The lesion takes the form of a caseous deposit which may or may not contain a sequestrum. Occasionally the tuberculous mischief is more diffuse. The indications are to remove the focus before the surrounding soft parts, including the tendon sheaths, become infected, and especially before the disease involves the astragalo-calcanean joint. The situation and nature of the focus is best determined by skiagraphy.

Operation. *When the focus is small,* it may be treated by

reflecting the soft parts, together with the periosteum, off the bone in the form of a flap. The part of the cortex of the bone superficial to the focus is then chiselled away and the disease in the interior removed by gouging, which should extend well into the surrounding healthy bone. If the focus has given rise to local thickening at any part of the bone, the incision should be so planned as to expose that particular region. In dissecting a flap off the outer aspect of the bone the convexity of the incision should reach downwards well below the peroneal tendons, and these, along with the subjacent periosteum, should be dissected up along with the flap. In other cases a similar flap will have to be dissected up from the inner aspect of the heel, in which case care must be taken to avoid injuring the posterior tibial vessels and nerves or their plantar divisions.



FIG. 37. A CASEOUS TUBERCULOUS FOCUS IN THE OS CALCIS. Skiagram from a child aged two years. Note the sequestrum in the centre of the tuberculous focus. (*By Dr. E. Price.*)

When the disease is more diffuse, the best plan is to make a horseshoe incision a little above the borders of the heel opposite the insertion of the tendo Achillis. Externally the incision may extend forwards as far as the base of the fifth metatarsal bone, while internally it should end a little behind the bifurcation of the posterior tibial vessels about a finger's breadth from the internal malleolus. In the adult, if the whole of the os calcis is to be removed, a second incision must be carried from the horizontal incision vertically upwards along the outer edge of the tendo Achillis for an inch or more. The details of the operation have been described by Mr. Burghard (Vol. I, p. 602). When the operation is being performed for tuberculous disease, however, it is important to remove the bone as far as possible subperiosteally.

In the child the operation is much simpler, so that the addition of a vertical incision is not necessary. In making the horizontal incision the knife is carried not merely through the periosteum, but also through the shell of cartilage which surrounds the cancellated tissue of the developing bone. The plantar portion of the cartilage is reflected off the osseous tissue along with the soft parts. By means of a gouge and sharp spoon the diseased focus, along with the whole of the surrounding cancellated bone, can readily be removed, leaving the cartilaginous shell intact. If desired, the cavity may be filled with Mosetig-Moorhof's iodoform-wax. The writer's experience, however, is that the new bone forms perfectly well if the cavity be allowed to fill simply with blood-clot.

A few catgut sutures are introduced posteriorly to unite the divided insertion of the tendo Achillis and the adjacent cartilage. No drainage is required unless a sinus exists, in which case the cavity should be stuffed with iodoform gauze. If the operation be performed before the articular cartilage has become infected, neither the calcaneo-astragaloid nor the calcaneo-cuboid joints are opened into. As the result of leaving the cartilage the bone is very largely re-formed.

After-treatment. The after-treatment consists in keeping the foot at right angles and avoiding pressure on the heel. In the adult this is best done by an anterior metal suspension splint, which is fixed to the limb above and below the wound by means of a plaster of Paris bandage. The splint is provided with hooks, to enable the limb to be suspended from a cradle. Though there is very little re-formation of bone in the adult the result is very satisfactory, especially if a pad be worn inside the heel of the boot.

OPERATIONS FOR TUBERCULOUS DISEASE OF THE ANKLE-JOINT

Operation. In tuberculous disease of the ankle-joint which has advanced in spite of rest and constitutional treatment, the writer almost invariably excises the joint by Kocher's method of dividing the anterior and external lateral ligaments of the ankle and then dislocating the foot inwards. A long J-shaped incision is made at the outer aspect of the ankle. The vertical limb of the incision extends well up behind the lower part of the fibula. while the curved portion, which reaches down to the peroneal tubercle, is carried up on to the dorsum, to end opposite the tendon of the peroneus tertius just external to the musculo-cutaneous (superficial peroneal) nerve. The external saphenous vein and nerve lie immediately below the incision.

The skin flap, along with the fascia and the periosteum covering the external malleolus, is dissected forwards off the peronei, the external

malleolus, and the anterior ligament of the tibio-fibular articulation. Below and in front of the malleolus the flap is dissected off the origin of the extensor brevis digitorum, the outer attachments of the lower division of the anterior annular (cruciate) ligament, the broad anterior fasciculus of the external lateral ligament, and the outer part of the thin anterior ligament. It is through the latter structure that the disease in the joint is very liable to penetrate. The abscess which results is generally



FIG. 38. A CASEOUS TUBERCULOUS FOCUS IN THE HEAD AND NECK OF THE ASTRAGALUS. This had given rise to secondary synovial disease of the ankle, the astragalo-calcanean and the astragalo-scaphoid joints. The skiagram was taken before operation from a child aged three and a half years. The astragalus was excised and the cartilages and synovial membrane of the adjacent joints removed. The foot was maintained in good position by a nail driven through the soft parts of the heel and the os calcis into the tibia. (*By Dr. E. Price.*)

covered by the flap, and is therefore easily dissected off its deep surface after it has been reflected.

The sheaths of the two peroneal tendons are next slit up, the tendons themselves are divided a little in front of the external malleolus, and the portions above are detached along with the periosteum from the groove behind the fibula.

The base of the flap, including the extensor tendons, is now retracted well forwards and inwards so as to allow of the detachment of the anterior

ligament subperiosteally from the anterior border of the lower end of the tibia as far inwards as the internal malleolus. The same ligament is also detached from the neck of the astragalus (talus), but the astragalo-scaphoid (talo-navicular) joint is not opened into at this stage.

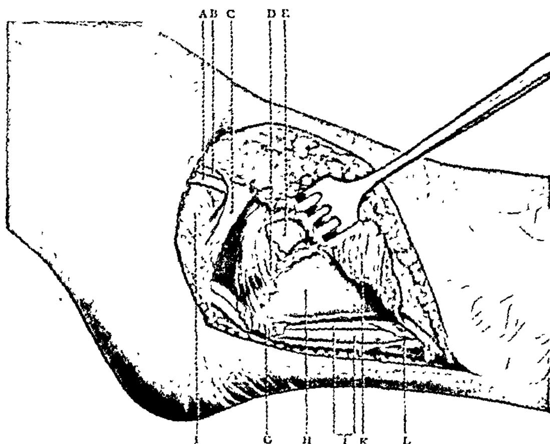


FIG. 39. EXCISION OF THE ANKLE BY KOCHER'S EXTERNAL J-SHAPED INCISION. The flap, including the periosteum covering the external malleolus, has been reflected forwards; the peroneal tendons with their sheath slit up are seen behind the fibula; the body of the astragalus has been exposed by dividing the anterior ligament immediately in front of the anterior fasciculus of the external lateral ligament. The external tendons, the anterior annular ligament, and the origin of the extensor digitorum brevis are exposed at the lowest part of the wound. A, Peroneus tertius tendon; B, Extensor digitorum longus; C, Anterior annular ligament; D, External lateral ligament; E, Astragalus; F, Extensor digitorum brevis; G, External annular ligament, H, External malleolus; I, Peronei tendons; K, Periosteum; L, Sheath of the peronei tendons.

The next step consists in dividing the bands of the external lateral ligament by carrying the knife well upwards under cover of the external malleolus. By wrenching the foot forcibly inwards, it can now be completely dislocated over the internal malleolus so that the sole looks almost directly upwards. The upper surface of the astragalus (talus) is thus thrust downwards and outwards into the wound, and a free

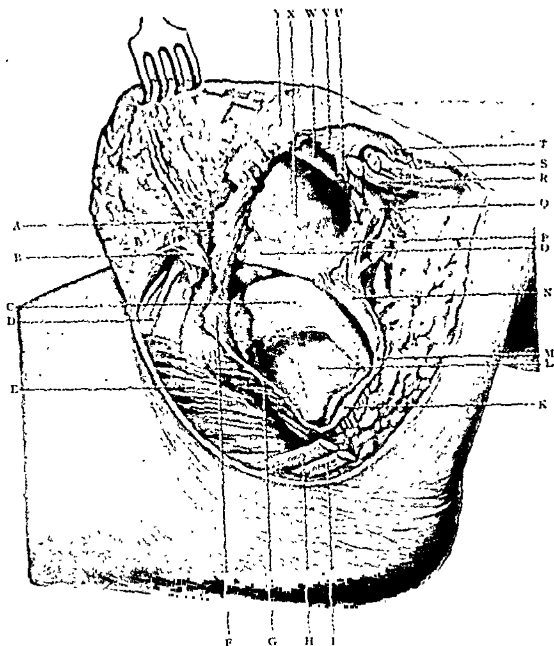


Fig. 40. Further Stage of the Operation shown in the previous Figure. The anterior, external, and posterior ligaments of the ankle have been divided, and the joint cavity fully exposed by forcible dislocation of the foot inwards. The peroneal tendons have been divided, also the outer attachment of the lower division of the anterior annular ligament. A, F, Anterior ligament of the ankle; B, Anterior annular ligament; C, Astragalus; D, Peroneus tertius; E, Extensor digitorum brevis; G, K, External lateral ligament of the ankle; H, Peroneus brevis; I, Peroneus longus; L, Astragalus; M, Q, Posterior fasciculus of the external lateral ligament; N, P, Posterior ligament of the ankle; O, Internal malleolus; R, S, Peronei tendons; T, External annular ligament; U, Middle fasciculus of the external lateral ligament; V, Anterior fasciculus of the external lateral ligament; W, External malleolus; X, Tibia; Y, Periosteum.

exposure of the joint is obtained. The internal lateral (deltoid) ligament is left intact as a hinge on which the foot rotates. It not infrequently happens, in forcibly dislocating the foot, that the periosteum, along with the internal lateral ligament, is either partly stripped from the internal malleolus or a portion of the latter is broken off; this is rather an advantage than otherwise, as it gives better exposure of the inner part of the joint cavity.

By detaching the posterior ligament, along with the transverse ligament, from the posterior border of the tibia, the foot can be so completely dislocated that every part of the joint cavity is brought well into view.

The next step in the operation consists in the removal of all the diseased synovial membrane, care being taken to clear out the recesses at the inner and posterior aspects of the joint. The thin posterior ligament of the ankle-joint had better be removed along with the synovial membrane; in doing this the deep flexor tendons and the posterior tibial vessels and nerve must not be injured. The internal lateral ligament may generally be left intact.

The stage is now reached when the operator decides as to whether it will be necessary to remove the whole of the astragalus. Some surgeons recommend its removal as a matter of routine whether it be diseased or not, the reason given being that unless the whole bone be excised, sufficient access is not obtained for the removal of the rest of the disease. This argument does not apply, however, if Kocher's dislocation method be adopted. If the astragalus itself be not diseased, the writer prefers simply to chisel off its articular surfaces. In doing this the raw surfaces left must be carefully shaped so that the remnant of the bone fits accurately into the tibio-fibular arch, which is also denuded of its cartilage. If, on the other hand, there be a primary focus in the astragalus, if it be the seat of extensive articular caries, or if the disease has invaded the astragalo-calcanean (talo-calcanean) joint, the whole bone must of course be removed. In looking for a primary focus in the astragalus the upper surface of its neck should be carefully examined, as it is in this situation that a small opening is not infrequently found leading into the joint.

To remove the astragalus the head should first be freed. This is done by dividing the outer attachment of the lower division of the anterior annular ligament and detaching the origin and posterior part of the extensor brevis digitorum. The peroneus tertius and extensor tendons are retracted well upwards and inwards. The posterior and outer part of the astragalo-scaphoid (talo-navicular) capsule is now exposed, and by dividing it in the coronal plane the head of the astragalus (talus) is laid bare. A sharp hook is then inserted into the astragalus, and while

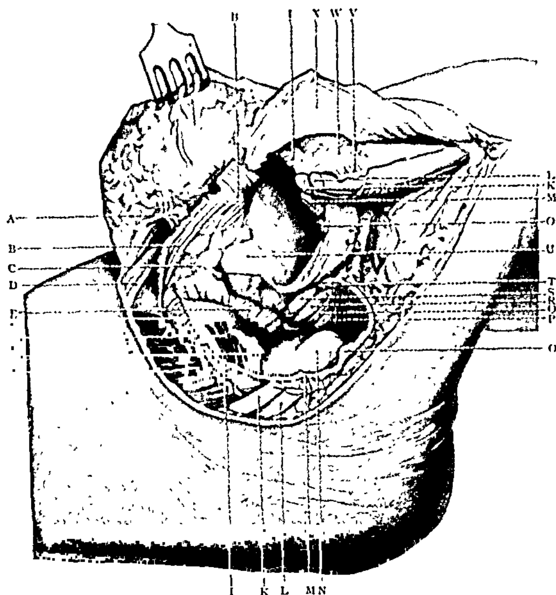


FIG. 41. FURTHER STAGE OF THE OPERATION SHOWN IN THE TWO PREVIOUS FIGURES. The astragalus has been removed, exposing the articular surfaces of the scaphoid and the os calcis. The internal lateral ligament has been partly detached subperiosteally from the internal malleolus; the posterior ligament of the ankle has been partly removed, exposing the deep flexor tendons along with the posterior tibial vessels and nerves. The extensor digitorum brevis has been divided at its origin from the os calcis. A, Anterior annular ligament; B, B, Anterior ligament of the ankle; C, Synovial membrane; D, Peroneus tertius; E, Internal lateral ligament; F, Astragalo-scaphoid ligament; G, Interosseous ligament; H, Extensor digitorum brevis; I, I, Anterior fasciculus of the external lateral ligament; K, K, Peroneus brevis; L, L, Peroneus longus; M, M, Middle fasciculus of the external lateral ligament; N, Os calcis; O, O, Posterior fasciculus of the external lateral ligament; P, Posterior tibial nerve; Q, Posterior tibial artery; R, Flexor digitorum longus; S, Tibialis posticus; T, Posterior ligament; U, Internal malleolus; V, External annular ligament; W, External malleolus; X, Periosteum.

the bone is dragged upwards a knife is introduced beneath it so as to divide the strong interosseous ligament between it and the os calcis. To completely free the astragalus all that is needed is to detach it from the internal lateral (deltoid) ligament; to do this the foot is forcibly inverted so that a strong sharp hook may be inserted into the inner surface of the astragalus, which is dragged downwards and outwards, while the internal lateral ligament is divided close to the bone, or separated at its attachment with a strong sharp rugine. By keeping close to the bone the tendons at the inner ankle (especially the tibialis posticus) and the posterior tibial vessels and nerves escape injury.

Having removed the astragalus, the upper surface of the os calcis is freed from disease by removing the synovial membrane and chiselling away its articular surface. The synovial membrane of the astragalo-scaphoid joint is then examined; if it be found infected secondary to the focus in the astragalus, the whole of the astragalo-scaphoid capsule must be removed, and along with it the posterior articular surface of the scaphoid (navicular).

The removal of all disease having been effected, the next step is to see that the foot is accurately fitted into the tibio-fibular arch, and securely fixed there at a right angle, with no tendency either to inversion or eversion. The ultimate functional, as well as cosmetic, result depends largely on the care with which this part of the operation is carried out.

Reference has already been made to the careful shaping of the astragalus in removing its articular surfaces. When this bone has been completely removed it is generally necessary to reduce the breadth of the os calcis by chiselling off the sustentaculum tali. If this precaution be not taken permanent deformity results; the foot becomes displaced outwards and the internal malleolus projects unduly.

The articular surface on the upper aspect of the os calcis must be removed so as to leave a horizontal surface; this is attained by making the slice slightly wedge-shaped, the base of the wedge being directed posteriorly. If this point be not attended to, when the bones are brought into apposition it will be found that the foot is too much flexed towards the dorsum. Again, when the astragalus has been removed, the external malleolus must be shortened somewhat, and it is an advantage to gouge away part of the outer surface of the os calcis so as to leave a slightly hollowed out raw surface to receive it.

To keep the bones accurately and firmly in position during the healing of the wound the writer is in the habit of using a long, square, plated nail, which is driven through the skin of the heel, the os calcis (calcaneus), and the remains of the astragalus (if not completely removed) up into the tibia for a couple of inches or so. Great care must be taken to see

that the assistant holds the foot in the best possible position while the nail is being driven in.

Before closing the wound the divided peroneal tendons are sutured and replaced behind the external malleolus, and if possible secured there by stitching any remains of the sheath and deep fascia over them with buried catgut sutures. If the peroneal sheaths have become secondarily

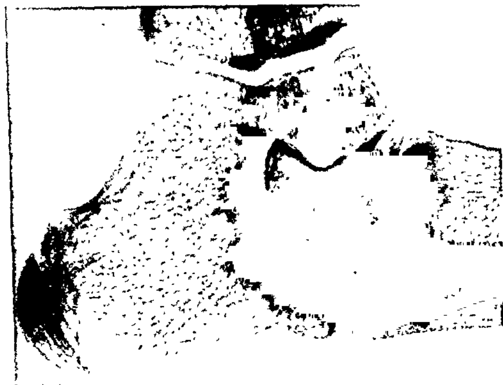


FIG. 42. RESULT OF EXCISION OF THE ANKLE. Skiagram taken six years after an operation performed when the child was nine years of age. The astragalus was not completely removed. There is no inversion or eversion, and no lateral displacement of the foot; the internal malleolus is a little more prominent than the external. The foot is shorter and narrower than its fellow. There is only very slight movement at the ankle itself, but this is partly compensated for by exaggerated movement at the mid- and posterior tarsal joints. The limb is ¾ inch shorter than its fellow. (*By Dr. E. Price.*)

infected they must of course be carefully dissected away. The same applies to the sheaths of the flexor tendons at the inner ankle.

Abscess formation in the region of the external malleolus has already been referred to. An abscess in the region of the internal malleolus does not, as a rule, call for a separate incision at the inner side of the ankle. After the bones have been dealt with, what remains of the abscess can readily be dissected away from within at the close of the operation.

If desirable, drainage may be provided for by passing a tube across

the front of the ankle beneath the extensor tendon and bringing it out through a button-hole opening just in front of the internal malleolus. Drainage, however, is seldom necessary unless the disease has reached the stage of sinus formation.

After-treatment. The after-treatment is greatly facilitated by the use of the nail, which is kept in for three weeks or so. The patient is quite unconscious of its presence, and as it gradually becomes somewhat loosened, its removal is unattended with pain. The limb is placed in any convenient form of posterior splint which possesses a foot-piece. The wound is dressed in a fortnight to take out the stitches, and a week or two later the nail is removed and a plaster of Paris case applied.



FIG. 43. RESULT OF EXCISION OF THE ANKLE AND ASTRAGALUS. Skiagram taken nine years after an operation performed when the child was two years old. There is no inversion or eversion, and no lateral displacement of the foot; there is movement at the ankle in the direction of dorsiflexion to the extent of 15°. (*By Dr. E. Price.*)

Results. Of the sixteen excisions of the ankle performed by the writer in the last ten years, eleven have been traced. Three of these died of general tuberculosis. In the remainder there is no return of the disease and the wounds are all soundly healed. The functional result is good in all but one case in which both ankles were excised. In this patient both feet are displaced outwards and considerable discomfort exists from pressure on the prominent internal malleolus. In two others there is slight outward displacement of the foot, which, however, gives rise to no inconvenience. The remainder are able to walk well without irons or lateral supports of any kind. Two indulge freely in football. Osseous ankylosis is present in one case, and this is compensated for by the increased mobility of the anterior and mid-tarsal joints. In the remainder there is slight flexion and extension at the ankle. In one the peroneal tendons are displaced in

front of the external malleolus. The disease was purely synovial in half the cases; in the other half, with the exception of two, the primary disease was in the astragalus. An abscess or fistula was present in one-third of the cases. The average duration of stay in hospital before dismissal with the limb in plaster of Paris was four weeks.

MIKULICZ'S OSTEOPLASTIC RESECTION OF THE FOOT

This operation is indicated in tuberculous disease of the posterior tarsus when the soft parts above the heel are so involved that disarticulation at the ankle is out of the question. The procedure consists in the removal of the soft parts of the heel together with the astragalus and os calcis, and the approximation (after sawing off the articular surfaces) of the scaphoid and cuboid to the tibia and fibula, the foot being maintained in the extreme equinus position so that the patient walks on the heads of the metatarsal bones with the toes hyperextended.

With the patient placed in the lateral or prone position, a transverse incision is made across the sole from the tuberosity of the scaphoid to a little behind the base of the fifth metatarsal bone. A second transverse incision is made behind the ankle between the centre of the bases of the malleoli. The extremities of these incisions are joined by two oblique incisions placed one on each side of the ankle. All four incisions extend down to the bone. The foot is forcibly dorsiflexed and the ankle-joint is opened from behind. With the foot still further flexed towards the leg, the ligaments of the joint are divided and the soft parts are dissected off the astragalus until the scaphoid and cuboid are reached. If the ankle-joint itself be free from disease, the dorsal bridge of soft parts should be separated as far as possible subperiosteally, while if the ankle-joint be diseased the anterior ligament should be removed, care being taken not to wound the dorsalis pedis artery, which, through its anastomosis with the external plantar, is the main source of blood-supply to the remainder of the foot. If the mid-tarsal joint be diseased, the scaphoid and cuboid should be sawn across without opening into it, or, if necessary, the section should be made further forwards through the cuneiform bones and the cuboid; if, on the other hand, the mid-tarsal joint be healthy, the astragalus and os calcis may be removed before the articular surfaces of the scaphoid and cuboid are sawn off. The articular surfaces of the tibia and fibula are next sawn off horizontally, and, after ligaturing the vessels, the remainder of the foot is brought into a line with the leg and maintained in this position by wiring the bones. If the tarsal bones have been sawn vertically and the tibia and fibula horizontally, as they should be, the metatarsals will be in the same straight line as the leg.

The divided ends of the posterior tibial nerve should be sutured if possible, but if this cannot be done no great harm results, as the intrinsic muscles of the foot are of very little use after this operation. Rose 'dissects the nerve out beforehand and takes care to leave it intact' (Cheyne and Burghard, *A Manual of Surgical Treatment*, vol. iv, p. 248).

When the wound is sutured, the soft tissues on the dorsum form a redundant fold opposite what was the centre of the lateral incisions; this redundancy, however, gradually disappears. Drainage is seldom necessary, but if desirable a tube, or strip of iodoform gauze, may be passed across the limb beneath the redundant bridge of soft tissues.

A strip of strong aluminium, or malleable iron, should be applied to the posterior aspect of the limb and bent forwards at a right angle opposite the metatarso-phalangeal joints so as to keep the phalanges hyper-extended. As soon as the wound is healed a plaster of Paris case is applied.

The disadvantages of this operation are (1) that should osseous ankylosis not occur, the functional result is very unsatisfactory; (2) it is often a long time before the patient is able to bear his weight on the limb; (3) the special boot which is required is difficult to make; (4) the limb is lengthened, consequently the sole of the opposite boot must be thickened.

The above operation may be converted into a *complete tarsectomy* by making the transverse incision across the sole a little further forwards, and by dissecting the tarsal bones off the tissues on the dorsum as far as the bases of the metatarsal bones, which are then sawn across.

CHAPTER IX

OPERATIONS FOR TUBERCULOUS DISEASE OF THE KNEE-JOINT

In all cases where a doubt exists as to whether conservative treatment should be tried in the first instance, a skiagram should be taken. If a bone focus be revealed, operation should be performed without delay. If, on the other hand, there be no bone disease, conservative treatment may be tried in the early stages of the disease, but should no improvement occur within three months operation should be resorted to; this applies especially to young children, as the disease generally runs a more rapid course in them than in adolescents and adults.

OPERATIONS FOR TUBERCULOUS DISEASE OF THE SYNOVIAL MEMBRANE

When the disease in the synovial membrane is primary, and forms a localized focus which has not yet perforated into the joint, excellent results are obtained by arthrotomy and removal of the affected area of synovial membrane. If the focus be limited, the joint may be opened by a longitudinal incision on one or other side of the patella, according to the seat of disease, or if preferred, the incision may be more or less curved so as to enable a flap to be dissected back. When the disease is less accessible, or affects a larger area, the joint should be more freely opened, either by dividing the patellar ligament by the lower curved incision of Textor, or by detaching the tubercle of the tibia and everting the quadriceps apparatus by means of Kocher's external J-shaped incision.

The diseased synovial membrane may either be clipped away after dissecting the divided capsule from its outer aspect, or the joint may be freely opened into first, and the diseased membrane then dissected off the capsule. In either case care should be taken not to cut into the tuberculous tissue.

When the disease occupies the suprapatellar pouch, a curved incision, with its convexity upwards, is made above the patella. The lower part of the quadriceps, along with the skin, is reflected downwards off the synovial pouch, and the latter is then dissected off the supratrochlear portion of the femur. Before closing the wound the quadriceps is united

with buried catgut sutures. Passive movement is begun in about three weeks, and a fortnight later the patient is allowed to begin to use the limb.

In diffuse tuberculous disease of the synovial membrane when the disease is aggravated, and especially when it has extended to the peri-articular structures, an H-shaped incision may be employed with advantage. Cheyne and Burghard recommend this as the best routine incision for arthrectomy. 'The vertical incisions should reach from the upper limit of the suprapatellar pouch well on to the anterior surface of the tibia, and should be from 1 inch to 1½ inches away from the edges of the patella. These are deepened until the tendon of the quadriceps extensor is exposed. Division of this displays the fibrous capsule of the joint covered by fat and loose cellular tissue' (*Manual of Surgical Treatment*, Part IV, p. 209). The transverse incision which unites the vertical incisions crosses the centre of the patella.

In cases of average severity the writer prefers the external J-shaped incision of Kocher. The advantage of this procedure is that, in addition to giving sufficient access to the disease, it preserves the quadriceps apparatus intact. The operation is performed as follows:—

Incision. The incision, which is external and somewhat J-shaped, begins 3 to 4 inches above the upper border of the tibia, extends vertically downwards about a finger's breadth external to the patella, crosses the outer tuberosity of the tibia, and then curves inwards about 1 inch below the tubercle of the tibia to end a little to the inner side of the crest. The integuments and the fascia lata having been divided, the fleshy fibres of the vastus externus (lateralis) are exposed in the upper part of the wound, while below is its aponeurotic tendon, which forms that part of the capsular ligament of the joint known as the external lateral patellar ligament. These structures, along with the subjacent synovial membrane, are divided along the whole length of the wound, and the outer aspect of the joint is thus freely opened into (external arthrotomy of the knee).

Free exposure of the interior of the joint. The outer border of the patellar ligament is defined and followed to its insertion into the lower part of the tubercle of the tibia, below which the periosteum is divided downwards and inwards for a short distance. The insertion of the patellar ligament is now detached along with the tubercle of the tibia and the periosteum immediately below it, care being taken to retain the attachment of the latter to the bone lower down. In the adult the tuberosity is detached with the chisel, while in the child the knife alone suffices, as the tuberosity is cartilaginous. The interior of the joint is freely exposed to view by dislocating the whole of the lower part of the quadriceps apparatus over to the outer side of the knee, and at the same time turning it inside out, so that the cartilaginous surface of the patella becomes

directed upwards. Before this can be accomplished, however, it is necessary to open the joint more freely from the front by hooking the patellar ligament forwards and outwards, and then separating the capsule and thick infrapatellar pad of fat from the anterior edge of the upper end

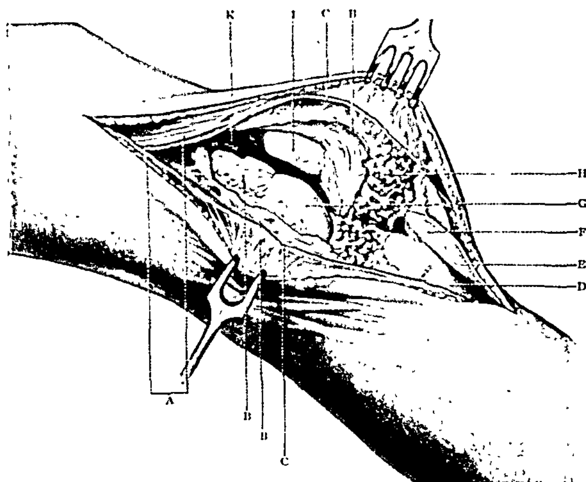


Fig. 44. The Arthrotomy Stage of Excision of the Knee by Kocher's external, slightly J-shaped Incision. The joint has been opened by dividing the lower fibres of the vastus externus, the capsule, and the synovial membrane. The outer part of the infrapatellar pad of fat has been divided; below it is seen the cartilaginous tubercle of the tibia and the adjacent periosteum partly detached from the anterior surface of the tibia. A, Vastus externus; B, B, B, Synovial membrane; C, C, Capsule; D, Tibia; E, Periosteum; F, Tubercle of the tibia; G, External condyle; H, Infrapatellar pad; I, Patella; K, Suprapatellar pouch.

of the tibia. If there be no strong intra-articular adhesions, and especially if the cavity of the joint contains a quantity of tuberculous débris, the quadriceps flap can be dislocated without difficulty. To enable the interior of the joint to be still more freely exposed, the crucial ligaments are now divided, and, if necessary, the lateral ligaments may be more or less completely detached subperiosteally from the femoral condyles.

Before proceeding further, the interior of the joint is carefully examined

and the extent of the disease ascertained. When, as is generally the case, the synovial membrane is diseased throughout, the crucial ligaments must be removed, otherwise sufficient access cannot be got for the removal of the synovial membrane lining the pouches behind the condyles.

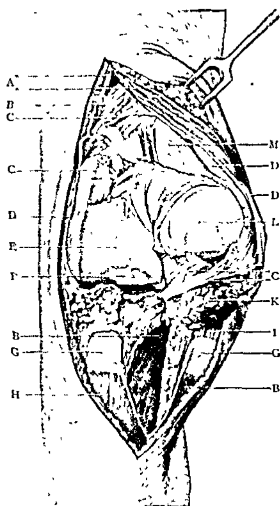


FIG. 45. FURTHER STAGE OF EXCISION OF THE KNEE BY KOCHER'S INCISION. The infrapatellar pad of fat, the synovial membrane covering its upper surfaces, the tubercle and adjacent periosteum have been more completely separated from the tibia so as to allow the lower part of the quadriceps, the patella, and the patellar ligament to be completely everted and displaced over to the inner side of the knee. The synovial membrane is well seen, as is also that lining the suprapatellar pouch. A, Vastus externus; B, B, B, Periosteum; C, C, C, Synovial membrane; D, D, D, Capsule; E, Femur; F, Ligamentum mucosum; G, G, Tubercle; H, Tibia; I, Patellar ligament; K, Infrapatellar pad; L, Patella; M, Rectus tendon.

Removal of the synovial membrane. This should be done by toothed forceps and knife dissection, aided by scissors curved on the flat. When the right knee is being operated on, the dissection is most conveniently effected from below upwards. The whole of the infrapatellar pad of fat and the synovial membrane covering its upper surface is first removed, then that lining the deep surface of the quadriceps on either side of and above the patella, including the anterior wall of the subcrureus bursa. When the summit of the pouch has been reached, its posterior wall, along with the subsynovial fat—often considerably thickened from chronic œdema—is dissected cleanly off the supratrochlear portion of the femur. The synovial membrane covering the lateral aspects of the condyles is more closely adherent to the bone. Care must be taken to see that all the membrane is removed from the inner side of the joint, where it is reflected from the internal condyle on to the adjacent portion of the capsule.

With the knee fully flexed and the assistant supporting the leg vertically, and at the same time

drawing the upper end of the tibia forwards, the operator now detaches the semilunar cartilages from the upper surface of the tibia and dissects the crucial ligaments cleanly away from the intercondyloid notch; or, if preferred, he may simply clear the intercondyloid notch and leave the semilunar cartilages to be removed at the same time that the articular cartilage is sawn off the tibia.

The sawing of the bones. With regard to the articular surfaces of the bones, they may either be sawn off so as to leave two flat surfaces, or the operator may follow the advice of Kocher and saw the tibia so as to leave a concave surface, while the femur is sawn so as to leave a correspondingly convex surface. If the former plan be adopted, an ordinary amputation saw with a movable back will suffice. The latter method, which requires some little practice, necessitates the use of a bow saw so made that its blade, which should be narrow, may be fixed at any angle. In primary synovial disease only a thin slice should be removed from the tibia. The saw should be kept in a plane exactly parallel to the articular surface, and caution should be exercised when the posterior edge of the bone is approached.

In sawing the femur it must be remembered that the shaft of the *femur does not occupy the axis of the thigh. The upper end is thrust* outwards by its head and neck, but owing to the greater length of the internal condyle as compared with the external, the lower surfaces of both lie in the same horizontal plane when the patient stands erect. It follows, therefore, that the femur must be sawn in a plane at right angles to the axis of the limb and not to that of the femur, or, what comes to the same thing, in a plane parallel to the under surface of the condyles. Unless this rule be kept in mind, the inexperienced operator is liable to remove too much bone from the internal condyle, with the result that when the tibia is brought into position it is found to be misdirected inwards. Another error which is even more liable to be committed is the removal of too much bone from the front and too little from the back of the condyles, the result being that when the bones are brought into apposition the leg is tilted forwards so as to produce an angular genu recurvatum. It is not a bad fault, however, to err a little in the opposite direction and direct the saw a trifle upwards as well as backwards, so as to produce a few degrees of flexion, the cosmetic as well as the functional result of which is rather better than that produced by an absolutely straight limb.

When there is no osseous disease of the femur, there is no necessity to remove more than the lower third of the condyles, so that, laterally, the section should fall below the level of the attachment of the lateral ligaments. When, as in this operation, the patella is left, it is well to saw off its articular surfaces. A corresponding flat surface is fashioned for

it on the femur by sawing off the remains of the prominent external condylar portion of the trochlear surface of the femur.

The next step is the removal of the remains of the synovial membrane from the back part of the joint, namely, that which covers the posterior ligament as well as that which lines the pouches behind the remains of the condyle. While this is being done, the knee should be flexed, and the tibia and femur should be drawn as widely apart as possible so as to stretch out the posterior ligament. Much assistance will be got by dragging the lower end of the femur upwards and backwards with a strong double hook placed in what remains of the intercondyloid notch. The posterior ligament is freed from synovial membrane by means of scissors curved on the flat. The azygos artery, which generally spurts, is secured with forceps and ligatured. Unless the ligament itself is infiltrated with tubercle, it should not be removed, as it not only protects the popliteal artery from injury, but forms a barrier against tuberculous infection of the popliteal space. Any tuberculous membrane about the sheath of the tendon of the popliteus muscle should be followed up and removed. Finally, a careful search should be made for a sinus leading through the posterior ligament into an abscess in the popliteal space, or into the semimembranosus bursa. If necessary, a counter-opening should be made posteriorly by cutting down on the blades of dressing forceps projected backwards under the skin from the main wound so as to avoid the vessels.

Arrest of hæmorrhage and drainage. These may be with advantage considered under the same heading. In the absence of sinuses and mixed infection there is no necessity for drainage, provided (1) that no antiseptic solution be used to wash out the wound, and (2) that the bleeding be carefully arrested before closing the wound. The best way to prevent after-bleeding is not only to see that all the bleeding points are carefully ligatured, but also to avoid using a tourniquet. It is far better that whatever bleeding occurs should take place during, and not after, the operation. The vessels forming the anastomosis about the knee are comparatively small, so that, with a good assistant, there should be no loss of blood worth speaking about. In ligaturing some of the vessels, especially those lying in or close to the periosteum, the catgut may have to be carried under the vessel by means of a curved needle, otherwise the ligature will slip. Troublesome oozing may be arrested by the pressure of gauze wrung out of hot saline solution. The great advantage of being able to dispense with drainage is that the original dressing, always the most secure, need not be changed for three weeks or even longer.

Fixation of the bones. Considerable difference of opinion exists as to whether any step should be taken to secure firm approximation of the

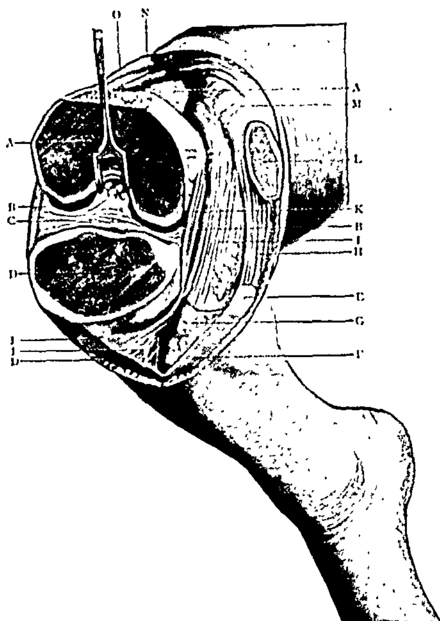


FIG. 46. LATER STAGE OF EXCISION OF THE KNEE BY KOCHER'S INCISION. The whole of the synovial membrane has been removed, with the exception of that lining the pouches behind the condyles. The articular surfaces have been sawn off the patella, the tibia, and the femur, and the upper part of the trochlear surface of the latter has been removed so as to leave a flat raw surface for the patella. Above the condyles the periosteum is seen covering the lower part of the shaft of the femur; between the patellar ligament and the internal lateral ligament appears that part of the capsule which forms the internal lateral patellar ligament; the floor of the wound between the femur and the tibia is occupied by the posterior ligament of the knee-joint, from which the synovial membrane has been removed. A, A, Femur; B, B, Synovial pouch; C, Posterior ligament; D, D, Tibia; E, E, Tubercle of the tibia; F, F, Periosteum; G, Infrapatellar pad; H, Patellar ligament; I, Internal lateral patellar ligament; K, Internal lateral ligament; L, Patella; M, Tendon of the rectus; N, Periosteum; O, Sawn trochlear surface of femur.

sawn surfaces beyond that afforded by careful external splinting. Of the various artificial means which have been adopted to give additional fixation the best is undoubtedly by means of two long square nails, each driven from the tibia obliquely upwards into the femur. While it cannot be said that the introduction of the nails is essential, especially when the capsule, the lateral ligaments, and the quadriceps apparatus have been preserved practically intact, it must be admitted, on the other hand, that in cases in which the patella has been removed, and both lateral ligaments divided, the nails are a distinct advantage. If properly introduced they certainly do no harm,—indeed, the patient is quite unconscious of their presence. Not only do the nails ensure osseous union, but they also render the after-treatment much easier. The firm fixation afforded by the nails does away with any necessity for complicated splints, and plaster of Paris need not be employed until after the wound is soundly healed. For these reasons the writer makes frequent use of the nails after excision in the adult, even by Kocher's method. While introducing them the surgeon should satisfy himself that the assistant is holding the bones accurately and firmly in position. After the quadriceps flap has been replaced, but not yet sutured, each nail is pushed through the skin immediately below the tuberosity of the tibia and then driven obliquely upwards into the opposite femoral condyle. Care must be taken that the nails are kept sufficiently parallel to the bones to prevent their points from penetrating into the popliteal surface of the femur. In some cases the bones are found to have been so firmly united by the one nail that the introduction of a second is unnecessary. The nail should be of such a length that by the time it is passed well into the femur only about ½ inch is left projecting outside the skin : the advantage of this is that the head of the nail may be covered by the dressing.

Closure of the wound. Before closing the skin wound the tubercle of the tibia is sutured into position with catgut (wire is seldom necessary) and interrupted sutures of the same material are used to close the incision in the vastus externus (lateralis) and subjacent capsule. The skin wound is united with silkworm-gut, in preference to silk and catgut, as it can be left in for a longer time without fear of setting up stitch suppuration. It is better not to use intermediate horsehair sutures, as it is well to encourage the blood-stained serum to escape between the silkworm-gut sutures.

An abundant sterilized gauze dressing should extend well above and below the wound. Plenty of wool, sterilized or sublimated, should be applied outside the gauze, taking in also the foot, and the whole is fixed in position with a domett bandage applied with some degree of firmness.

The splint the writer prefers is the one used by Macewen after his

operation for knock-knee. This is practically a Liston's long splint, with the addition of a posterior support extending from just below the fold of the buttock to a little beyond the foot. An oval opening is cut out opposite the heel, and another opposite the external malleolus. The splint is well padded, and fixed to the limb with a roller bandage and to the chest with a binder. A figure-of-eight bandage should be placed separately round the foot, to keep it at a right angle. The posterior part of the splint, besides giving good support to the knee, prevents rocking and rotation outwards. It is an advantage to keep the hip quiet, at any rate until the wound is healed. As a rule the dressing need not be disturbed until the end of the third or fourth week, when the stitches and nails may be removed. A plaster of Paris case is substituted for the splint, and the patient is allowed to get about by the aid of crutches and a patten. This first plaster case should include the pelvis. Two or three months later the plaster should be renewed, but without including the hip. As a rule it is not advisable to allow the patient to bear weight on the limb without some support until six months have elapsed from the date of operation.

OPERATIONS FOR TUBERCULOUS DISEASE OF THE KNEE-JOINT SECONDARY TO A FOCUS IN ONE OF THE BONES

Unless the disease is so extensive that amputation is called for, the operation is practically the same as that above described, with the addition of one or two steps directed towards the removal of the disease in the bone. Small foci, whether situated in one of the condyles or tuberosities, are dealt with by thorough curetting, either before or after the articular surface of the affected bone has been removed. A sharp spoon generally suffices for the purpose, but if the adjacent bone be sclerosed, or if the focus invades the cortex, a gouge and hammer will be required. If the focus be larger and deeper, or if a sequestrum of considerable size be present, the affected condyle or tuberosity may be sawn through beyond the seat of the disease at a deeper level than its fellow. The opposite bone is dealt with in a similar, but converse, manner. The result of this manœuvre is to produce two *Z*-shaped sawn surfaces, which must be so fashioned that when the limb is brought into good position they dovetail accurately, the one into the other. In other cases, instead of sawing the bones in the above zigzag fashion, an oblique section is made from before backwards or from side to side according to the position of the focus. The slice of bone removed is thus wedge-shaped, with the disease towards the base of the wedge. The extremity of the opposing bone is also sawn obliquely, and care must be taken that the surface which is left is in a plane exactly parallel to the first, otherwise when the tibia is brought into apposition with the femur it will be found to be mis-

directed. When it has been necessary to saw the bones obliquely they should be nailed into position to prevent the risk of a gliding movement between the two surfaces; one nail is sufficient.

In cases in which the whole epiphysis is destroyed, or in which a focus in the end of the diaphysis, either of the femur or of the tibia, has been allowed to run its course until first the adjacent epiphysis and then the joint has become involved, amputation will be called for. Such an unfortunate state of affairs is unlikely to occur in the case of the lower end of the femur, but the writer has met with it in neglected cases of tuberculous disease at the upper end of the diaphysis of the tibia.

OPERATIONS FOR PRIMARY TUBERCULOUS DISEASE OF THE PATELLA

This condition is probably not so rare as is generally supposed. The operator occasionally discovers it accidentally while excising a tuberculous knee. It is a good rule, therefore, always to saw off the cartilages of the patella in performing this operation. If a diseased focus be revealed, the whole bone had better be removed, but the periosteum and rectus tendon should be preserved if possible. This is easily done if Kocher's excision be performed. After everting the quadriceps flap, all that is necessary is to divide the periosteum around the margin of the patella, and then to peel the bone off the periosteum covering its anterior surface.

Cheyne and Burghard (*Manual of Surgical Treatment*, Part IV, p. 215) recommend the removal of the patella in most cases when excising the knee for tuberculous disease. After dissecting up a horseshoe-shaped flap from the front of the joint and directing the assistant to hold it well up out of the way, 'a vertical median incision is made through the quadriceps from the top of the suprapatellar pouch down to the tubercle of the tibia. This incision is very carefully deepened above until the muscular fibres are cut through, when the handle of the knife can be sunk between the muscle and the capsule and the two structures separated from one another. The periosteum over the patella is then turned off to either side with a raspatory, and the ligamentum patellæ is split longitudinally.'

When it is obvious, before operation, that the joint-disease is secondary to a focus in the patella, the technique of the operation is so planned as to include removal of this bone at an early stage of the operation. It is in cases of this kind that the method of excision of the knee recommended some years ago by A. G. Miller (*Transactions of the Edinburgh Medico-Chirurgical Society*, vol. xii, p. 16), and performed by him practically as a matter of routine, is particularly advantageous. The following is Mr. Miller's description of the operation :—

'1. Incision from behind and above one condyle of femur to corresponding point of opposite side, brought down to near tubercle of tibia with a well-rounded sweep. Second cut straight across about middle of patella.

'2. Flap of skin from upper incision (that across patella) reflected up till muscular fibres of vasti are seen. These carefully cut through. *Tendon of rectus cut very carefully as it lies embedded in the thickened* synovial membrane. Then muscles and tendon raised with handle of knife and fingers till upper border of thickened synovial membrane defined. Diseased mass of synovial membrane then dissected downwards off femur, mainly with handle of knife and fingers, till attachment at articular surface of femur is reached and cut through. Lateral attachments cut. Last of all, attachment to tibia and ligamentum patellæ cut through, and thus anterior portion of diseased synovial membrane removed *en masse*, with patella in centre and elliptical portion of skin attached.

'3. All remaining visible synovial membrane scraped away in detail from lateral ligaments and anterior crucial ligament,—joint being flexed for this purpose. Semilunar cartilages removed, and joint made clean so far. Then lateral and anterior crucial ligaments cut, and the posterior ligaments scraped and cleaned thoroughly. All ligaments scraped when *in situ* and tense, or cut away.

'4. Enough of bone removed from femur and tibia to thoroughly open the cancellated tissue to inspection, and all osseous tubercular foci dealt with.

'5. *After approximation of bones, tendon of quadriceps may be stitched* to remains of ligamentum patellæ, and then skin flap brought down and stitched. Drainage provided from posterior ends of incision.'

In primary tuberculous disease of the patella without involvement of the knee-joint, J. B. Murphy (*Surg. Gyn. and Obstet.*, March, 1908) operates as follows :—

'(*a*) Preliminary preparation of the joint, which consists of producing a chemical inflammation in the joint by injecting 2 to 6 drams of 2 to 5% solution of formalin in glycerine (which is prepared twenty-four hours before needed), a week or ten days before the operation. We induce this chemical inflammation preparatory to all arthrotomies for patellar fractures, movable cartilages, &c. By the preparatory treatment of the joint, a local immunity is developed, through the infiltration of the tissues and the occlusion of all the lymph-spaces, induced by the chemical inflammatory reaction. Trauma, in the way of dissection or handling in these joints, will not produce a large quantity of effusion, as it does in non-immunized joints. They offer a much greater resistance against infection.

'(*b*) Open the knee-joint by a 7-inch incision in the outer side of the patella.

'(*c*) Make a subaponeurotic excision of the patella, leaving ends of quadriceps tendon and ligamentum patellæ exposed.

'(*d*) Prepare the flap, for the extension of the quadriceps tendon downward, by splitting the *quadriceps tendon* and *vastus externus* muscle

from point H to point E, dividing the vastus externus transversely to F, and splitting it back to I; then turn the flap downward, with its fascial side to the joint, and approximate point H of the flap to C of ligamentum patellæ, and point F of flap to B of ligamentum patellæ. It may be united end to end, or may overlap the patellar ligament. The fascia and its fat should be turned toward the joint. This flap is used as a substitute for the patella, and is an extension of quadriceps tendon. The suture is done with kangaroo tendon, silk, or chromicized gut, or it may be accomplished with a figure-of-eight silkworm-gut suture, supporting the outer loop with a gauze pad, so that it does not cut into the skin. This is probably the most desirable, as well as the strongest, method of suture.

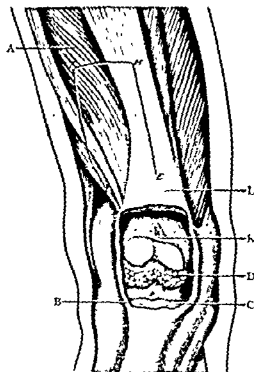


FIG. 47. EXCISION OF THE PATELLA. Anterior view of the joint with the patella excised. A, Quadriceps; B, Capsule; C, Ligamentum patellæ; D, Infrapatellar pad; E H F I, Flap from the quadriceps; K, Supratrochlear surface of the femur; L, Quadriceps tendon. (*After Murphy.*)

'(*e*) Suture the aponeurosis of patella securely to the divided edge of the deep fascia, and continue until the quadriceps tendon and muscle are entirely embedded. Close the rent left in the vastus externus by buried catgut sutures.

'(*f*) Insert a superficial drain from the joint surface to the lower angle of the wound.

'(*g*) Dress in a straight posterior splint.'

Results. As far as the certainty of curing the disease goes, excision gives better results in the knee than in any other joint, but unfortunately at the expense of loss of mobility. The preservation of the other functions, namely, stability and weight-bearing capacity, can practically be guaranteed. In diffuse tuberculous disease of the knee-joint, the writer has practically given up all operative procedures which do not aim at producing osseous ankylosis. Simple arthrectomy, better termed synovectomy, either alone or combined with division of the crucial and lateral ligaments, rarely gives satisfactory results If the crucial and lateral ligaments be not divided, there is a great risk of recurrence due to incomplete removal of the disease at the posterior aspect of the joint, especially from the pouches behind the condyle ; and if the patient escapes recurrence

he is generally left with a more or less stiff and bent knee. If, on the other hand, the crucial and lateral ligaments be divided, an unstable knee generally results; hence the rule should be to remove enough of the articular surface to make sure of osseous ankylosis.

It is often stated that excision of the knee is contra-indicated in young children on account of the shortening which results. In primary synovial

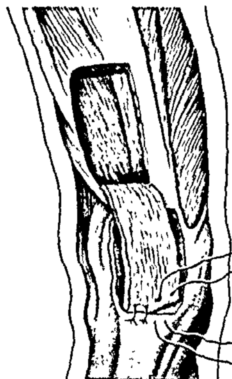


FIG. 48. EXCISION OF THE PATELLA. Extension flap placed in position. (*After Murphy.*)

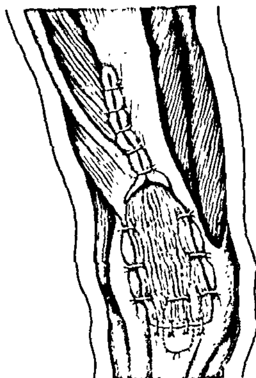


FIG. 49. EXCISION OF THE PATELLA. Shows the line of suture for the flap and closure of the rent in the quadriceps muscle. (*After Murphy.*)

disease, however, there is no necessity to interfere with the epiphyseal cartilages. The following table prepared by Dr. W. L. Robertson, formerly House Surgeon at the Royal Edinburgh Hospital for Sick Children, gives the after measurements of as many of the writer's old cases of excision of the knee in children as could be traced. If we include the three cases in which cuneiform osteotomy was performed for bending subsequent to excision, the average amount of shortening was 1½ inches, of which the femur accounted for 1 inch and the tibia for ½ inch. Nearly all authors in referring to shortening after excision of the knee seem to agree that an amount which does not exceed 2 inches is so easily compensated for that it is of little practical importance. It will be noted that in four cases there was no shortening whatever. In two of these the excision was

performed during the third year of life ; in one the limbs were measured four years after operation, and in the other nearly three years after. In compensating for the average amount of shortening the sole of the opposite boot need only be heightened to the extent of about ½ inch, the remainder being more comfortably counteracted by slight drooping of the pelvis and slight pointing of the toes. If both limbs be the same length, the patient is obliged to swing the ankylosed limb outwards in order to clear the ground, whereas if the ankylosed limb be allowed to be 1 inch shorter than its fellow, the patient can advance the limb much more comfortably. This can be accomplished by heightening the sole of the boot on the sound side to an extent varying from ½ to 1 inch.

Age at Operation.	*Age at Measurement.*	*Shortening.*	*Age at Operation.*	*Age at Measurement.*	*Shortening.*
0–2: $1\frac{5}{12}$	$8\frac{1}{2}$	$2\frac{1}{2}$" (after cun. resection)	6–8: $6\frac{1}{12}$	13	$1\frac{1}{2}$"
2	9	¾"	$6\frac{9}{12}$	16	½"
$2\frac{8}{12}$	8	0"	7	14	$3\frac{1}{2}$" (after cun. resection)
$2\frac{11}{12}$	6	0"	7	12	$1\frac{1}{2}$"
3–5: 3	9	½"	8	14	½"
4	11	2"	8	12	2"
$4\frac{10}{12}$	13	$1\frac{1}{4}$"	8	11	$1\frac{1}{4}$"
$4\frac{10}{12}$	12	0"	$8\frac{8}{12}$	$12\frac{1}{2}$	2"
$4\frac{10}{12}$	12	$1\frac{1}{2}$"	9–11: $9\frac{2}{12}$	15	4" (after cun. resection)
$5\frac{1}{12}$	14	$1\frac{3}{4}$"	10	19	$1\frac{1}{2}$"
$5\frac{7}{12}$	15	0"	$10\frac{4}{12}$	18	1"
			11	15	$1\frac{1}{4}$"
			11	$13\frac{1}{2}$	$2\frac{1}{2}$"
			$11\frac{6}{12}$	$61\frac{1}{2}$	2"

A more important bad result of excision of the knee than shortening is bending at or close to the seat of operation. This, if at all marked, gives rise to serious deformity, and greatly aggravates the shortening. Fortunately it is a rare complication. It occurs almost invariably after excision in children, and the rule is for it to take place in the first year, or two years, after the operation.

Of the two forms of antero-posterior bending, the more common is the backward variety, in which the bending is due to the formation either of an angle at the junction of the two bones or to curvature of the lower part of the shaft of the femur. In the other variety, namely, genu recurvatum, the tibia may either be bent forwards at an angle at its junction with the femur or the upper part of the tibia may be curved. The angular deformities at the junction of the two bones are due either to faulty sawing of the bones, to their incomplete apposition, or to too early use of the limb. The deformity, on the other hand, which is produced by a curvature above or below the junction of the two bones is

a static condition due to bending of the growing bone at the end of the diaphysis rather than to any error in the technique of the operation. This latter deformity comes on more gradually and is later in its onset than is the case with the angular bending at the seat of operation. No



FIG. 50. SKIAGRAM FROM A CHILD AGED 8 YEARS, TAKEN TWO YEARS AFTER EXCISION OF THE KNEE BY KOCHER'S METHOD FOR DIFFUSE TUBERCULOUS INFILTRATION OF THE SYNOVIAL MEMBRANE. The lower end of the femur was pared, leaving a convex surface, the tibia leaving a correspondingly concave surface. The articular surface of the patella was removed, also a slice of cartilage from the femur opposite the patella. Note the complete osseous ankylosis, also how little the epiphyses have been interfered with. Amount of shortening = ½ inch. (*By Dr. E. Price.*)

attempt should be made to deal actively with the curvature until after it has become stationary. In the case of the femur, the simplest plan is to fracture the femur above the condyles by osteoclasis and to maintain the corrected position by means of a plaster of Paris case. Failing this a simple osteotomy should be performed. The operation of cuneiform resection for ankylosis of the knee in the flexed position has been described by Mr. Burghard (Vol. I, p. 632).

OPERATION FOR ANKYLOSIS WITH GENU RECURVATUM

The principle of the operation is the same as that for ankylosis in the flexed position, but the technique is a little more troublesome as access cannot be got directly to the base of the wedge owing to its being directed towards the popliteal space. The incision, which must therefore be made over the concavity of the bend, may be planned with the object of dissecting upwards a single square flap, or, if preferred, two flaps may be made by means of an H-shaped incision. If the patella be present, it had better be removed. The remains of the quadriceps tendon and the subjacent periosteum are separated from the bone in the form of two short flaps, a resection knife and a strong sharp rugine being used for this purpose. In removing the wedge, the upper section is made first, the edge of the saw being directed upwards as well as backwards. The lateral soft tissues are well retracted backwards out of the way of the saw, which is used cautiously towards the posterior aspect of the bone; the latter is not completely divided for fear of wounding the popliteal artery. The posterior cortex is fractured by using the leg as a lever, a fulcrum being provided by placing a sand-bag behind the lower part of the thigh. With the leg flexed so that the raw surface of the lower fragment faces upwards, a wedge, with its base directed posteriorly, is now removed by applying the saw to its anterior margin and directing it downwards as well as backwards. The breadth of the base of the wedge will of course be proportionate to the severity of the deformity. As soon as the saw reaches close up to the posterior surface of the bone, the latter is fractured across by levering the fragment upwards and backwards with the saw. In one instance, where the bone was considerably sclerosed, the writer found it necessary to complete the section with an osteotome. The wedge of bone is grasped with lion forceps and partly twisted and partly dissected away from the thickened periosteum, which protects the structures in the popliteal space. All sharp edges and irregularities are carefully trimmed away from the bones before they are brought into position. If the deformity has not been completely corrected, a second slice must be removed from whichever bone seems the more suitable for the purpose. When the limb has been brought into good apposition, it will generally be found that the divided quadriceps and periosteum have become too much drawn apart to admit of their approximation by buried sutures. The integuments, however, are sufficiently elastic to allow the skin wound to be closed. Drainage is not necessary. Here, as in a typical excision of the knee, the writer has found it an advantage to nail the bones together. The after-treatment is the same as for excision of the knee.

CHAPTER X

OPERATIONS FOR TUBERCULOUS DISEASE OF THE HIP AND SACRO-ILIAC JOINTS

OPERATIONS UPON THE HIP-JOINT

Widely different opinions have been expressed as to the relative value of conservative and operative measures in the treatment of tuberculous arthritis of the hip-joint. It cannot be said even yet that the question has been definitely settled, but the prevailing view at present seems to be that, in the early stage of the disease, appropriate mechanical treatment, aided by suitable constitutional and hygienic means, is generally capable of arresting the disease, and that the functional result is as a rule better than that which is to be obtained from an early excision.

In hospital practice, unfortunately, by the time the surgeon sees the patient the disease has often already advanced beyond the first stage, and very commonly presents some of the following clinical features: The region of the hip is swollen; the muscles of the thigh are atrophied; the limb is more or less flexed and adducted; the trochanter is thickened and frequently more or less elevated above Nélaton's line, while if there has been erosion and migration of the dorsal margin of the acetabulum, the head of the femur can be felt to form a prominence immediately above and behind the great trochanter. Deep-seated fluctuation may be felt beneath either the ilio-psoas or the tensor fasciæ femoris, in the adductor region, or posteriorly in the neighbourhood of the partially dislocated head of the bone. Any attempt to move the joint generally gives rise to more or less severe pain, and to reflex rigidity of the muscles guarding the joint. If the limb be examined while the patient is anæsthetized, the rigidity will largely disappear, and on rotating the femur grating may be detected in the joint. Few will deny that such cases as the above, especially among the poorer classes, are best treated by excision.

Operation. Here, just as in tuberculous arthritis elsewhere, while the chief aim of the operation is the removal of the disease, every endeavour should also be made to obtain as good a functional result as possible. Unfortunately the anatomy of the hip-joint is such that these two indications can only be imperfectly fulfilled. By excising the

head and neck of the femur we can remove the primary focus, but by the time the disease has advanced far enough to demand operation, the synovial membrane and the acetabulum will almost certainly be involved. It would appear, too, that the acetabulum is more frequently the



FIG. 51. TUBERCULOUS HIP-DISEASE. Skiagram from a child aged 5 years, showing an elongated and slightly wedge-shaped tuberculous focus in the under surface of the neck of the femur. The joint itself is not yet involved. This is a typical case for conservative treatment. (*By Dr. E. Price.*)

primary seat of the disease than was formerly supposed. It follows, therefore, that whatever incision be employed it should give access, not merely to the head and neck of the femur, but also to the acetabulum and to the synovial lining of the capsule.

The anterior route recommended by Hueter and Barker gives good

access to the femur but not to the acetabulum, and for this reason it is not to be recommended for advanced cases. The conditions for which this operation would be most suitable are cases in which the disease in the head or neck of the femur has not yet given rise to secondary infection of the joint. Such cases, however, are best treated by conservative means.

The method of Langenbeck, namely, by the external vertical incision, is best adapted for those cases in which it is necessary to remove the trochanter as well as the head and neck of the femur.

In the opinion of the writer, the operative procedure recommended by Kocher is to be preferred to any other, as in addition to giving good access to the femur—trochanter as well as head and neck—it undoubtedly gives the best access to the acetabulum. Moreover, it has the great advantage of being applicable in practically all cases in which either arthrotomy or excision is indicated, and for this reason the writer has come to employ it almost exclusively.

Before describing the technique of the operation, one or two preliminary points are worthy of mention. The disinfection of the skin must not be confined simply to the buttock; it should include the lower part of the abdomen and back as well as the thigh. Special attention should be paid to the gluteal cleft and perineum. It is well also, as an additional precaution, to smear the anal region with sublimated iodoform. In arranging the sterilized sheets, it should be remembered that during the operation the affected limb has to be manipulated in various directions by an assistant; it must therefore be enveloped separately in an additional sheet from the toes up to a little below the buttock, while, to prevent it from slipping, a sterilized cotton bandage should be applied over it.

Supposing the right hip to be affected, the patient is placed on the left side in the semi-prone position, with the left thigh extended and the right flexed and adducted across it. The incision employed by Kocher is an angular modification of Langenbeck's external vertical incision. The upper half of the incision, which is placed obliquely, runs parallel to the fibres of the gluteus maximus, and practically also to the axis of the head and neck of the femur; it extends from the posterior superior angle of the great trochanter upwards and backwards towards the posterior superior spine of the ilium. The length of this portion of the incision will necessarily vary somewhat according to the obesity of the patient and according also to the amount of upward displacement of the femur. The lower half of the incision extends from the posterior superior angle of the great trochanter downwards in the axis of the femur to a short distance below the root of the trochanter. With the affected

limb held in the flexed position the incision will be found to be more curved than angular.

Having divided the skin and subcutaneous tissue, the gluteus maximus is exposed. The fleshy portion above and behind the trochanter is split

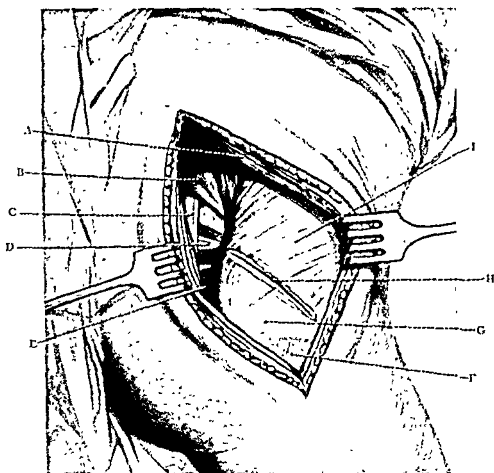


FIG. 52. FIRST STAGE OF EXCISION OF THE HIP BY KOCHER'S POSTERIOR ANGULAR INCISION. The gluteus maximus is split in the direction of its fibres; its edges are retracted, exposing the insertion of the gluteus medius into the outer surface of the great trochanter. The periosteum of the latter has been incised immediately below and parallel to the insertion of the gluteus medius. Above and behind the trochanter are seen from above downwards, the pyriformis, the edge of the great sciatic nerve, the obturator internus with the gemelli, and the quadratus femoris. A, Gluteus maximus; B, Pyriformis; C, Great sciatic nerve; D, Obturator internus; E, Quadratus femoris; F, Vastus externus; G, Root of the trochanter; H, Incision; I, Insertion of the gluteus medius.

in the direction of its fibres, while the aponeurotic portion, which covers the outer aspect of the trochanter, is divided vertically with the knife until the upper part of the glistening tendon of the vastus externus is exposed. A branch of the superficial division of the gluteal artery is

secured in the fleshy part of the muscle, while in the aponeurotic portion forceps may have to be applied to the anastomosis between the transverse branch of the external circumflex artery and the first perforating branch of the profunda. When the head of the femur is displaced



FIG. 53. ARTHROTOMY STAGE OF KOCHER'S EXCISION OF THE HIP. The insertions of the gluteus medius and minimus, and of the pyriformis, have been separated from the great trochanter subperiosteally and retracted upwards and forwards. The head and neck of the trochanter are exposed by dividing the postero-superior portion of the capsule in the coronal plane. A, Pyriformis; B, Capsular ligament; C, C, C, Gluteus maximus; D, Root of the trochanter; E, Vastus externus; F, Obturator internus; G, Gluteus medius; H, Head of the femur.

upwards, the upper part of the incision may be made at the level of the upper border of the gluteus maximus, which is then freed and retracted downwards. The same procedure may be adopted when the disease has spread from the acetabulum upwards into the ilium.

On retracting the edges of the gluteus maximus the following structures are exposed from above downwards, a layer of fatty tissue occupy-

ing the hollow above and behind the great trochanter, the insertion of the gluteus medius covering the upper and anterior part of the great trochanter, the periosteum covering its posterior and lower part, and, lastly, the upper part of the aponeurosis of the vastus externus (lateralis). After clearing away the fatty tissue above mentioned, and applying forceps to any divided vessels forming the anastomosis between the sciatic and internal circumflex arteries, the lower border of the gluteus medius is defined. Below it is the pyriformis muscle, the tendon of which cannot be followed to its insertion until after the gluteus medius has been detached from the great trochanter. Below the pyriformis are the obturator internus, the gemelli, and the upper fibres of the quadratus femoris. The sciatic vessels and nerves need not as a rule be exposed.

The next step in the operation consists in detaching the insertion of the gluteus medius. This is done by dividing the periosteum from the posterior superior to the anterior inferior angle of the trochanter, and then detaching the tendon upwards and forwards until the upper and anterior borders of the trochanter are exposed. In the child, this is readily effected by using a resection knife and including a slice of the subjacent cartilage along with the tendon; in adults, on the other hand, the operator must use either a strong sharp rugine (Farabeuf's), or he must apply the hammer and chisel and detach a layer of bone along with the tendon.

By retracting the separated insertion of the gluteus medius well upwards and forwards with a sharp double hook, the insertion of the gluteus minimus is reached and may, if necessary, be more or less completely detached from the anterior border of the trochanter. The tendon of the pyriformis, now freely exposed, is detached from the trochanter and retracted either upwards and forwards with the glutei, or downwards and backwards along with the obturator internus and gemelli. The former procedure is adopted when there is no displacement upwards of the femur, while the latter is preferable when the head of the bone is displaced upwards. The insertions of the obturator internus and gemelli are separated and retracted downwards. While the above muscles are being detached from the trochanter, a third assistant manipulates the thigh so as to render the individual tendons as accessible as possible.

The posterior part of the capsule is now fully exposed, and when there is marked flexion and adduction combined with upward and backward displacement of the femur, more or less of the head of the bone may be felt projecting outside the acetabulum, the posterior part of the capsule being stretched over it. In the cases where an abscess has formed, and is still confined to the cavity of the joint, tense fluctuation may be felt

beneath the capsule. When there is little or no flexion and adduction deformity it is a good plan to break down any adhesions before commencing the operation. If this be done, the third assistant is generally able, by flexing, adducting, and rotating the thigh inwards, to cause a considerable portion of the head of the bone to project against the capsular ligament.

The posterior part of the capsule, after being fully exposed, is incised in the coronal plane over the projecting head of the femur parallel to the pyriformis, either immediately above or immediately below it. The opening is then extended right up to the margin of the acetabulum and well down to the trochanter. By rotating the limb inwards as fully as possible, and at the same time pushing the thigh well upwards and backwards, the head of the femur is made to project through the opening. Should the ligamentum teres still be present, it must be divided at its attachment to the femur either with a probe-pointed knife or by scissors curved on the flat. To bring the femoral attachment of the ligament into view the thigh should be flexed, adducted, and rotated inwards.

At this stage of the operation it is the duty of the operator to make a careful examination of the various components of the joint in order to ascertain the precise nature and extent of the tuberculous mischief. The head (epiphysis) and neck (end of the diaphysis) should be examined in the first place. A description of the various morbid conditions which may be met with is not within the scope of this article. Suffice it, therefore, to say that in cases of morbus coxae which have reached the stage at which operation is justifiable, removal of the head and neck of the femur is almost invariably demanded. Perhaps the only possible exception to this rule is when the disease is confined to the synovial membrane, but even in these cases, if the disease be at all advanced, the removal of the head of the bone is generally necessary in order to give sufficient access for the removal of all the diseased synovial membrane. Another conceivable exception may be mentioned, namely, the presence of a primary osseous focus in the lower part of the neck of the femur which has not yet given rise to secondary infection of the synovial membrane. It is very unlikely, however, that such a localized morbid condition would give rise to symptoms calling for operation. In cases in which radiography has demonstrated such a condition, Huntingdon has advised that the focus should be removed without opening into the joint by tunnelling into the neck from the outer aspect of the great trochanter. The writer has performed this operation with advantage in the early stage of acute infective osteomyelitis of the neck of the femur, but it is doubtful if all the disease can be removed in tuberculous cases without the joint being opened into.

Most authorities are agreed that, whether the head of the femur be much diseased or not, it is wiser to remove it. The neck of the femur, especially the region of the calcar, is a common situation to meet with a primary osseous focus, and when this is present the whole neck should

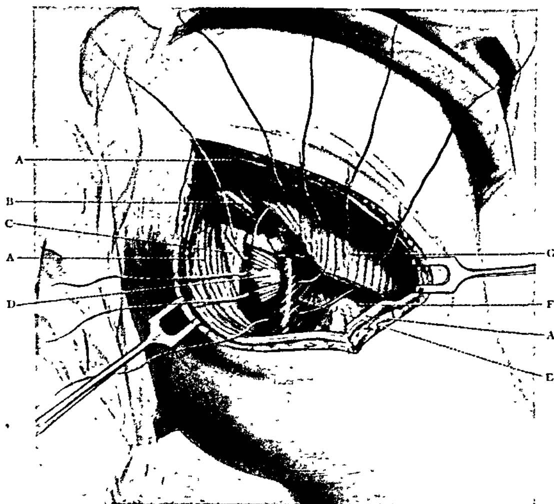


FIG. 54. LATER STAGE OF KOCHER'S EXCISION OF THE HIP. The head and neck of the femur have been removed. The upper end of the trochanter has been rounded off and placed in the acetabulum, with the limb in the abducted position. The capsule has been closed by two deep stitches. Four other stitches, not yet tied, are seen uniting the gluteus medius to the obturator internus, gemelli, and quadratus femoris. A, A, A, Gluteus maximus; B, Pyriformis; C, Great sciatic nerve; D, Obturator internus; E, Quadratus femoris; F, Vastus externus; G, Gluteus medius.

be removed along with the head. But even when the neck itself is free from disease it should be removed. The reasons in favour of this procedure will be evident when the after-treatment has been considered.

For dividing the neck of the bone the surgeon may use either Adams's saw, or, what is generally more convenient, a broad chisel (or

Jones's gouge-chisel) and hammer. The whole of the neck should be removed. To include the lower part of the calcar it may be necessary to apply the chisel a second time. The cut surface of the femur is carefully examined to make sure that the disease has not extended into the trochanter. If it has, it is often possible to remove it with a gouge, or by curetting with a sharp spoon. Should the disease be still more extensive, the periosteum must be completely separated from the trochanter and the whole of the latter removed. The separation of the periosteum is facilitated by adding to the oblique incision already mentioned a transverse one at the level of the root of the trochanter. Unless, however, the disease has invaded the trochanter, the latter should not be removed. To remove the trochanter simply for the purpose of draining the joint is, in the opinion of the writer, as unnecessary as it is mutilating.

Having removed the head and neck of the femur, attention is next directed to the acetabulum. Any remains of the ligamentum teres, along with the adjacent synovial membrane and Haversian pad of fat, should be removed in the first place. If the cartilage be healthy it should be left with the object of obtaining a movable joint. Any pitlike or digital depression seen on the surface of the cartilage must be curetted with a sharp spoon, to ascertain if it be connected with a tuberculous focus in the subjacent bone; if so, the focus must be thoroughly gouged out. Should the cartilage be extensively eroded, or replaced by tuberculous granulations, the whole cavity, along with the superficial carious bone, must be vigorously curetted until the surface which is left is normal both in appearance and consistence. At this stage of the operation it is not uncommon to find that at some point the disease has perforated the acetabulum, and it may have given rise to a caseous abscess between it and the obturator internus muscle. When this is the case the opening must be enlarged so as to admit of the abscess being thoroughly cleaned out. Should a sequestrum be present, it must of course be removed.

When the acetabulum is involved, Bardenheuer has recommended that it should be completely excised. The severity of such a procedure, together with the disability to which it gives rise, is such that most surgeons prefer to trust to an extensive use of the hammer and gouge, assisted by the sharp spoon. A case sufficiently advanced to warrant excision of the acetabulum would almost certainly call for disarticulation at the hip-joint.

Attention is next directed to the diseased synovial membrane lining the capsule, and also to any infected pockets or abscesses extending from it. All tuberculous débris and fungus-like granulations should be got rid of in the first place by the sharp spoon aided by vigorous wiping out with gauze, while adherent clumps of synovial membrane and diseased portions

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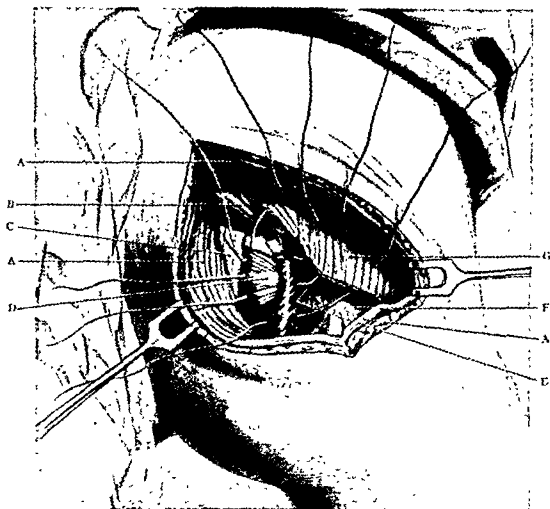


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be removed along with the head. But even when the neck itself is free from disease it should be removed. The reasons in favour of this procedure will be evident when the after-treatment has been considered.

For dividing the neck of the bone the surgeon may use either Adams's saw, or, what is generally more convenient, a broad chisel (or

cavity left to drain. If thought desirable, however, a strip of iodoform gauze may be passed down into the cellular space beneath the gluteus maximus. In the majority of cases, drainage may safely be dispensed with altogether, so that the wound need not be dressed until it is time to remove the stitches.



FIG. 55. PHOTOGRAPH OF THE AUTHOR'S ABDUCTION HIP-SPLINT. (*Photograph by Dr. Lewis S. Beesly.*)

After-treatment. Every precaution must be taken to maintain the hip in the abducted position during the entire period of the after-treatment. For this purpose the writer uses a simple but very efficient splint shown in Fig. 55 It is in reality a modification of the double long splint (box-splint) introduced many years ago by Hamilton for treating fractures of the lower extremity in children. The cross-piece, instead of being placed at the very end of the splint, as in Hamilton's, unites the two portions posteriorly a little above the heels. The splint is

of capsule are seized with toothed forceps (Kocher's artery forceps or Leedham Green's dissecting forceps), and clipped away with strong scissors curved on the flat. This part of the operation should as far as possible be done under direct inspection, and, if necessary, the opening in the capsule must be enlarged by an incision at right angles to the original incision.

The cavity of the joint and the wound may be douched out with sterilized salt solution, or, if preferred, a Barker's flushing spoon may be used for the curetting. Following this, some surgeons swab out the joint with a strong antiseptic, such as pure carbolic acid, followed by alcohol, or with chloride of zinc (40 grs. to the ounce). The disadvantage of this procedure is that drainage of the cavity becomes necessary. Instead of using any strong antiseptic, therefore, the writer prefers simply to rub some sublimated iodoform-bismuth paste over the interior of the capsule and the raw surfaces of the bones.

The upper border of the trochanter is now rounded off with a strong resection knife so as to make it fit into the bottom of the acetabulum when the limb is abducted. With the trochanter placed in this position, the patient is rolled gently back from the semi-prone position on to the sound side, the assistant keeping the affected thigh in the abducted and extended position. The operator now unites the deeper structures over the trochanter by means of interrupted catgut sutures, introduced either with a Doyen's handled needle or a suitable needle-holder. The deepest sutures close the opening in the capsule, the next layer unites the separated gluteus medius to the pyriformis and superior gemellus, while the third layer brings together the edges of the split gluteus maximus. The integuments are united with interrupted sutures of silkworm-gut. In children the silkworm-gut tends, after some days, to cut into the delicate skin. To prevent this, and to allow the stitches to be kept in for two or three weeks without disturbing the dressing, each suture, after it has been passed, but before being tied, is threaded at one end with a piece of fine rubber drainage tubing, about ¾ inch in length; when the suture is tied the tubing is left surrounding that portion of the loop which overlies the skin.

The question of drainage has been a good deal discussed in connexion with the operation of resection of the hip. Some writers have objected to Barker's anterior operation, on the ground that the drainage is unsatisfactory. The writer quite agrees with Barker that, in the absence of sinuses, and provided also the wound has not been washed out with an antiseptic, there is no necessity for drainage. If, as recommended above, the whole of the neck of the femur be removed and the trochanter be thrust into the acetabulum there is no necessity to drain the joint, as there is no

Throughout the subsequent dressings care must be taken to keep the limb in the exact position it occupied while in the splint, otherwise there will be a great risk of the trochanter becoming displaced from the acetabulum. The splint and dressings having been removed, the nurse, whose duty it is to maintain the abducted position of the limb, stands on the sound side of the patient, and, with one hand placed behind the child's back and the other grasping the leg above the ankle, she gently turns the child towards herself until it rests on its sound side (Fig. 57). The drain (or stitches) having been removed, and the wound dressed, the patient is rotated back into the supine position and the splint reapplied.



FIG. 57. THE METHOD OF MAINTAINING ABDUCTION DURING THE DRESSING AFTER EXCISION OF THE HIP-JOINT. (*Photograph by Dr. Lewis S. Beesly.*)

When the wound has soundly healed, which is generally at the end of three weeks, a plaster of Paris case is substituted for the splint, the limb being maintained in the abducted position. This first plaster case should extend from the metatarsus to the level of the nipples, the patient afterwards being allowed to get about by the aid of crutches and a patten added to the boot on the sound limb. To prevent hyper-extension of the knee a special pad of cotton-wool should be placed under the popliteal space. From below the middle of the thigh downwards, the case should be fairly thin, while in the region of the hip it should be strengthened by incorporating with it two strips of aluminium or Britannia metal, one placed anteriorly and the other externally. The addition of one part of dextrine to three parts of plaster of Paris makes the case much less brittle, and therefore less liable to crack.

padded with wool covered with jaconet waterproof. Besides giving a posterior support to the legs, this position of the crossbar is very convenient for lifting or carrying the patient while in the splint. To convert this simple splint into an abduction hip-splint, two modifications are necessary. The first is that the portion corresponding to the diseased side is sawn across opposite the hip, and the two parts united by a common



FIG. 56. PHOTOGRAPH OF A CHILD WITH ABDUCTION SPLINT APPLIED AFTER EXCISION OF THE HIP-JOINT. (*Photograph by Dr. Lewis S. Beesly.*)

hinge screwed on to the outer side of the splint ; the other alteration is that the two halves of the splint are separate from each other, each with its own cross-piece. The cross portions are made long enough for their free extremities to overlap when the affected limb is abducted to the desired degree. To maintain the abduction all that is necessary is to fix together the cross portions at the point where they overlap with a common screw-clamp The upper portions of the splint are of course secured to the chest by a broad binder

In the normal condition the weight of the trunk is not transmitted directly from the os innominatum to the shaft of the femur, but indirectly to it through the head and neck of the bone, which form an angle with the shaft varying from 160° in the new-born to 110° in the adult. By this arrangement the mechanical disability of the long axis of the os innominatum being practically parallel to the shaft of the corresponding femur is overcome, and the weight-bearing stability of the



FIG. 59. THE RESULT A YEAR AFTER EXCISION OF THE HIP BY KOCHER'S POSTERIOR ANGULAR INCISION. Skiagram from a child aged 11 years. Trochanter placed in the acetabulum with the limb abducted. The joint is ankylosed; there is no displacement upwards of the trochanter. Two inches of shortening. *(By Dr. E. Price.)*

joint maintained. If the limb be kept in the straight position after the head and neck of the femur have been removed, the osseous stability of the joint is lost, for the pelvis on that side is then merely slung to the limb by the remains of the capsule and certain of the muscles which pass from the pelvis to the femur. If under such conditions the patient attempts to bear his weight upon the limb the trochanter becomes displaced from the acetabulum upwards and outwards on to the ilium. The result is progressive lameness and deformity owing to shortening combined with adduction and flexion.

By placing the limb in the abducted position, on the other hand,

After three months a Thomas's abduction splint may, in some cases, be substituted for the plaster, while in others it is easier to apply a second plaster case which need only envelop the pelvis and the upper two-thirds of the thigh. No attempt should be made to reduce the abduction. At the end of six months or so from the operation there is, as a rule, no longer any necessity for the patient to wear a splint; he should, however, continue to use the crutches and patten for two or three months, so as to prevent

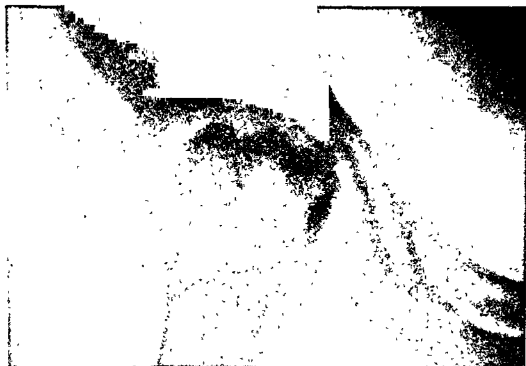


FIG. 58. THE RESULT THREE YEARS AFTER EXCISION OF THE HIP BY KOCHER'S POSTERIOR ANGULAR INCISION. Skiagram from a child aged 9 years. Note how the upward displacement is prevented by the trochanter being placed in the acetabulum with the limb maintained in the abducted position. Absolute ankylosis. Shortening = 2 inches. (*By Dr. E. Price.*)

him bearing his weight upon the excised joint. Lastly, the patten is removed and the patient gradually begins to bear his weight on the limb.

Judging from the literature on the subject, considerable difference of opinion would appear to exist as to the best position in which to place the limb during the after-treatment; by some the straight position is preferred, by others the abducted; some advocate extension, while others disapprove of it. The writer is strongly in favour of the abducted position. The reasons for, and the advantages of, this position will be found clearly set forth in a paper by my former House Surgeon, Dr. Lewis S. Beesly (*Scottish Med. and Surg. Journ.*, Aug., 1907).

by stretching the muscles under an anæsthetic, but, unless the patient continues to wear some form of splint or retention apparatus, the adduction is very liable to recur. Division of the adductors, followed by the placing of the limb in the abducted position, is, in many instances, the surest and best method of treating the deformity, along with the aggravated lameness to which it gives rise.

(iii) At the close of the operation for ankylosis with adduction.

Operation. The operation is performed as follows:—

Careful attention should in the first place be paid to the disinfection



Fig. 60. Quiescent Tuberculous Disease of the Hip. Skiagram from a child aged 6 years. The limb is slightly flexed and adducted. Note the upward displacement of the femur. The adductors were divided by the open method and the limb was put up in an abduction splint, and subsequently in the same position in plaster of Paris. (*By Dr. E. Price.*)

of the skin, not only in the groin, but also in the perineum, and especially in the deep cleft between it and the adductor region.

While the assistant attempts to abduct the thigh so as to put the adductors on the stretch, the surgeon makes a longitudinal incision from the origin of the adductor longus downwards along its prominent margin for two or three inches. After dividing the skin and subcutaneous fat, the deep fascia forming the sheath of the muscle is also divided longitudinally. The muscle itself is divided a little below its origin. Next, the inner edge of the skin wound is retracted so as to expose the anterior

the pelvi-femoral muscles and the weight of the body cause the femur to be pressed upwards and inwards towards the acetabulum, which furnishes a stable surface for the femur to act against. Another advantage of the abducted position is, that by drooping the pelvis on the affected side to bring the limbs parallel for the purpose of progression, the patient not only compensates for the shortened condition of the limb but at the same time maintains the abduction at the hip, and in this way prevents the tendency to upward displacement of the trochanter. The obliquity of the pelvis is of course compensated for by a secondary curvature of the spine. Instead of drooping the pelvis on the sound side, the shortening might be compensated for by providing the patient with a high boot on the affected side; but unless the operation has resulted *in either osseous or firm fibrous union, the danger is that the high boot,* by doing away with the necessity for the drooping of the pelvis, would favour upward displacement of the femur. It must be admitted, however, that the abducted position predisposes to ankylosis, either complete or partial. But there can be no doubt also that an ankylosed hip in good position is preferable to the progressive deformity and lameness associated with displacement upwards of the femur. For this reason the writer is not in the habit of applying extension after excision of the hip. The best position for an ankylosed hip is with the limb abducted, slightly flexed, and a little rotated outwards. The advantage of slight flexion is that the patient is able to sit with greater comfort.

OPERATIONS FOR THE CORRECTION OF DEFORMITIES RESULTING FROM TUBERCULOUS HIP-JOINT DISEASE

TENOTOMY OF THE ADDUCTOR MUSCLES

Indications. This operation is called for—

(i) As a preliminary to excision of the hip in advanced cases of tuberculous disease in which there is marked adduction combined generally with flexion, internal rotation, and upward displacement of the femur. In such cases, without dividing the adductors, it is often impossible after excising the head and neck of the femur to place the limb in the abducted position. A further advantage of dividing these muscles is that, if the joint should become unstable, the division of the adductors, by preventing adduction of the thigh, diminishes the tendency to upward and backward displacement of the femur. The operation may be performed at the same sitting as the excision.

(ii) In old quiescent, or healed, cases of hip-joint disease in which the limb, without being ankylosed, has become markedly adducted. In some of these cases the limb can be straightened either gradually or

TENOTOMY FOR FLEXION DEFORMITY

Any flexion deformity which remains after dividing the adductors can generally be got rid of by manipulation under an anæsthetic followed by subsequent weight extension. Should these means fail to correct the flexion, it will be necessary to divide the sartorius, the tensor fasciæ femoris, the fascia lata, and, in more aggravated cases, also the rectus. For this purpose a longitudinal incision is carried downwards from the anterior superior spine of the ilium in the interval between the tensor *fasciæ femoris and sartorius muscles. After dividing* these a little below their origin, the edges of the wound are retracted and the tendon of the rectus is divided. A branch of the external circumflex artery may require to be ligatured, while the external cutaneous nerve should, if possible, be avoided.

OPERATIONS FOR OSSEOUS ANKYLOSIS FOLLOWING HIP-JOINT DISEASE

Indications. Osseous ankylosis of one hip in the straight position is of very little consequence unless it is combined with flexion and adduction. A slight amount of flexion is rather an advantage than otherwise, as it allows the patient to sit with greater comfort. If the flexion be at all marked, and more especially if it be combined with adduction, the disablement becomes very great, and, unless there are weighty reasons to the contrary, operation should be urged. The adduction adds greatly to the lameness as well as to the deformity, as, in order to bring the limbs parallel for the purpose of progression, the patient is obliged to elevate the pelvis on the affected side and thereby to increase the shortening.

Various forms of osteotomy of the femur have from time to time been recommended for the treatment of ankylosis with malposition. The earlier methods took the form of a simple transverse subcutaneous osteotomy, the femur being divided either through the neck (Adams) or a little below the trochanter (Gant).

OPERATION FOR THE PRODUCTION OF PSEUDO-ARTHROSIS OF THE HIP WITHOUT DISARTICULATION OF THE HEAD

This operation, which we owe to Mr. Robert Jones, is indicated in those cases of tuberculous disease of the hip-joint in which ankylosis has occurred in a bad position without destruction of the head of the femur. The operation consists in 'removing a slice of the great trochanter, chiselling through the neck and screwing the separated portion of the trochanter to the proximal end of the neck in order to avoid union of

border of the gracilis, which is divided right back to its posterior border. The whole thickness of the adductor brevis is now divided, care being taken to avoid injuring the superficial and deep divisions of the obturator nerve, the former lying superficial to the muscle, the latter behind it upon the adductor magnus. In some cases the inner border of the pectineus may also require division. The best method of dividing the muscles is to isolate each one separately by a blunt dissector (Kocher's or Cheyne's) and then, while the muscle is put on the stretch, to cut it across with straight blunt-pointed scissors. The dissection scissors of C. H. Mayo answer both purposes admirably.

Any intervening bands of fascia which are felt to be stretched must also be divided, care being taken to avoid the internal circumflex artery and its branches. All bleeding points which can be detected on the cut surfaces of the muscles should be carefully ligatured so as to allow the wound to be closely sutured without drainage.

From the position of the wound it is obviously not advisable to apply an ordinary dressing fixed with a spica bandage. The writer is in the habit of treating the wound by simply smearing it over with sublimated iodoform-bismuth paste and taking precautions to prevent either the hands or the clothing from reaching it. Or, if preferred, the wound may be covered with one or two strips of iodoform gauze over which is applied a larger piece of gauze, the whole being secured in position by the free use of collodion. The advantage of avoiding a collodion dressing, at any rate during the first forty-eight hours, is that if any tension should occur within the wound it is relieved by the escape of the serum between the stitches. At the end of forty-eight hours, when the wound is perfectly dry, a collodion dressing may be applied. In the female great care must be taken to prevent the wound being soiled during urination.

After-treatment. For the first three weeks or so the patient is placed in an abduction splint similar to that used after excision of the hip; after this a Thomas's abduction hip-splint is applied and the patient allowed to get about on crutches. Should there be a tendency for the limb again to become adducted, the splint must be worn for a considerable time; and the more tendency there is to shortening and upward displacement the more should the limb be abducted

The benefit derived from free open division of the adductors in old healed cases of hip-disease with marked adduction is very striking; the child, in place of being a pronounced cripple, is able to get about with comparative comfort.

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the fragments. The neck may be chiselled close to the head or at a little distance, or the neck may be completely removed, or, where there has been destruction from disease, additional bone may be removed.'

The following is Mr. Jones's description of the operation :—

'A longitudinal incision is made about 6 inches in length with the upper border of the trochanter in its centre.

'An incision is made across the base of the trochanter just below the insertion of the gluteal muscles.

'A slice of the trochanter from this point to its junction with the neck above is sawn or separated by a very wide osteotome and retracted upwards. The capsule is now opened and the head separated from the neck with an osteotome.

'Extension is next put on the femur, and the trochanter with its muscles attached is screwed on to the head of the femur, which remains in the acetabulum.

'Deep and superficial sutures complete the operation.

'In the case of a tender joint, to avoid impinging, it may be necessary to remove a portion of the neck. In the case of an ankylosed sound joint following sepsis, it may be advisable, instead of dividing the neck near the acetabulum, to divide it near the trochanter.'

Mr. Jones commends the operation as 'very suitable to those advancing in years. It saves the shock of disarticulation, an all-important consideration.

'In bony ankylosis, where disarticulation has to be made with a chisel, the time saved is great, and the result is more reliable than where a flap of tissue intervenes, unless the piece of bone removed is considerable, while the removal of much bone involves the sacrifice of muscle and some control of movement. The femur remaining is well supplied with muscles for useful movement, and no stitching of capsule is needed for the prevention of displacement upwards.'

Kocher divides the bone obliquely immediately below both trochanters (oblique subtrochanteric osteotomy). This method possesses the advantages of leaving two broad osseous surfaces and of preventing the lower fragment from being displaced inwards when the limb is forcibly abducted. Cheyne prefers a cuneiform osteotomy at the junction of the neck with the trochanter, the base of the wedge being placed either superiorly or superiorly and posteriorly, according to whether the limb is simply adducted or flexed as well. He makes a free incision down to the bone between the sartorius and the tensor fasciæ femoris muscles.

In ankylosis following tuberculous disease of the hip, however, the head of the femur is often more or less absorbed, or the neck is abnormally short and thick. For this reason Adams's operation is seldom feasible, and Cheyne's may be unnecessarily difficult. The operation which the

writer is in the habit of performing is a cuneiform osteotomy, the wedge being removed immediately above the lesser trochanter (Volkmann) if the bone be not specially thickened; if it be, the wedge is removed immediately below both trochanters. The base of the wedge is directed externally if the ankylosis be attended with adduction only, while if there be flexion as well the base of the wedge is directed backwards as well as outwards.

The incision may be placed either transversely across the outer aspect of the root of the trochanter or longitudinally over the middle of its outer aspect. After dividing the skin and subcutaneous tissue, the aponeurotic insertion of the gluteus maximus is exposed and divided transversely. Beneath it is the great trochanter with the glistening tendon of the vastus externus lying immediately below it. The periosteum is now divided transversely across the outer aspect of the root of the trochanter, and, after separating it upwards and downwards with a strong sharp-edged rugine (Farabeuf's), the wedge is removed with the hammer and a broad, highly tempered chisel. The more the limb is shortened, the broader should be the base of the wedge so as to allow of the limb being well abducted. In removing the wedge it is well not to sever the bone completely until both sides of the wedge have been cut. During the operation the patient should be placed on the sound side, and a sand-bag (not too tightly filled) should be placed between the thighs so as to provide a firm and steady bed for the affected limb to rest upon. The sand-bag is covered with jaconet and completely enveloped by at least two layers of sterilized cotton sheeting. After the wedge has been removed, the periosteum and the fascia lata are united with buried catgut sutures. The skin wound is closed without drainage.

The limb is maintained in the abducted position by means of the splint already described. Before this can be done it will be necessary either to forcibly stretch or divide the adductor muscles.

After-treatment. There is no necessity to apply weight extension to the limb, as there is no fear of the osseous surfaces becoming displaced. Osseous union is aimed at, and the after-treatment is therefore conducted on the same lines as for simple fracture, care being taken that the limb is not allowed to become everted. The patient may be kept in the abduction splint for six weeks, but if desired a Thomas's abduction splint (or a plaster of Paris case) may be applied at the end of three weeks and the patient allowed to get about on crutches with a patten to raise the opposite limb. Two months after the operation the patient may begin to bear his weight upon the limb.

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observations, has introduced an arthroplastic method by means of which he has been able not only to correct the deformity, but to obtain at the same time a movable as well as a stable joint. After studying the formation of joint cavities in the embryo, of false joints following fractures, and of cavities and hygromata, he was able to show that a similar cavity developed between the two raw osseous surfaces of a severed ankylosed joint if a layer of aponeurosis, or fatty tissue, be introduced between them.

The following is Murphy's own description of the operation as performed by him for ankylosis of the hip-joint (*Journ. of the Amer. Med. Assoc.*, May 20 and 27, June 3, 1905):—

'A U-shaped incision was made, 5 inches wide, with its base upward, beginning 4 inches above the trochanter and extending downward 2 inches below it. The trochanter was exactly in the centre of the U. The incision was through the skin, superficial fat, and fascia lata, and these tissues were dissected upward as one flap. A long curved needle, threaded with heavy silk, was passed around the base of the trochanter beneath the muscles attached to it, and by means of this carrier a chain-saw was brought into position. The trochanter was then sawn off and retracted upward. The capsule of the joint was next incised and separated from the ilium all the way round. The attachment of the gluteus maximus was not disturbed. The bone was examined, and the neck of the femur was found to be continuous with the margin of the acetabulum by firm bony union. The formation of a new head for the femur and a new acetabular cavity was the next step in the operation, and was accomplished in the following manner: The bony tissue filling the acetabulum was chiselled free from the latter by following around its margin (the line of junction with the neck) with a carpenter's curved chisel, 1½ inches in diameter. The chisel each time was driven in obliquely towards the fossa acetabuli, the object of this being to make the new femoral head as nearly spherical as possible. When the chiselling process was completed, the new head was entirely separated from the sides of the acetabulum and was attached only at the bottom by a narrow bridge of bone. This bridge was fractured by forcible abduction of the limb, after which the head was dislocated from the cavity by external rotation of the thigh. The shape and contour were almost exactly those of a normal femoral head, except for a few sharp, bony projections which were removed by means of a bone-cutting forceps. A curette was used to smooth off the irregularities produced by the chisel and to enlarge the cavity. The fascia lata which formed a part of the original U-shaped flap was now dissected away from the subcutaneous fatty tissue down to its base, where the vessels entered to supply it with blood. The flap of fascia was then drawn down under the head of the femur and carefully fitted into the acetabular cavity to form a complete lining for it. The under surface of the flap, ½ inch from the edge, was sutured to the joint capsule around the acetabular margin with interrupted catgut sutures to secure it and to prevent its subsequent displacement.

'The new socket being in readiness, the head of the femur was returned

OPERATIONS FOR ANKYLOSIS WITH SINUSES

It is by no means uncommon to meet with old-standing hip cases in which the ankylosis with flexion and adduction is complicated with one or more sinuses which have persisted in spite of repeated attacks on them by the ordinary method of laying them open and curetting, followed by the application of a powerful antiseptic and gauze packing or drainage. In many of these cases the sinuses are prevented from healing by the presence of foci of osseous disease—often containing a sequestrum—imbedded in the region of the ankylosed joint, either in the innominate bone, in the remains of the head or neck of the femur, or in the trochanter. While amputation may be called for in exceptional cases, there are many cases in which by excising the joint the disease can be removed and the limb at the same time straightened.

Operation. The operation is carried out on the following lines: In the first place the sinuses are laid open, curetted, and disinfected either with pure carbolic acid or turpentine; those that lie in the region of the main operation wound may often be completely excised. Free access must be got to the ankylosed joint, and in the presence of adduction and flexion this is best effected by means of Kocher's postero-external incision. If the sinuses be carefully probed, one or more of them will be found to lead, either directly or indirectly, to the diseased focus in the bone, and whatever be its situation, this should be thoroughly gouged away, and, if necessary, the wound should be enlarged to give sufficient access to do this thoroughly. The next step consists in chiselling across the neck of the femur, and then gouging out the remains of the head of the bone from the acetabulum. Should the bone be dense this may be rather a laborious process. The writer has found the highly tempered gouge-chisels made by Weiss of London for Mr. Robert Jones very helpful for this purpose.

Should a focus of disease be discovered in the root of the neck or in the trochanter, it must be removed, after which the end of the latter should be so fashioned that it can be implanted into the gouged out acetabulum, the adductors being stretched, or if necessary divided, to allow the limb to be placed in the abducted position. A drainage tube should be introduced into whichever sinus leads most directly down to the joint, the others being packed with iodoform gauze. The after-treatment is the same as that described for excision of the hip.

While most surgeons in operating to straighten an ankylosed hip in malposition have not only been contented with, but have rather aimed at, osseous union, it is right to mention that J. B. Murphy of Chicago, as the result of careful developmental as well as pathological and experimental

hand strong pressure, combined with a sawing motion, over them near their points of origin, after the Lorenz method. The sartorius was divided with the scalpel close to its attachment to the anterior superior spine of the ilium. To retain the limb immobilized until the firm union of the parts was secured, a plaster cast was applied, including the pelvis and entire limb in full extension and abduction.

'The patient was put to bed and a Buck's extension, with 10-pound weight, was applied to the right leg. The wound healed by primary union. . . . Examination showed that the hip-joint allowed of fully 20% of the normal amount of rotation, and from 20 to 30% of the normal amount of flexion and extension.'

Nine months later the father reported that the patient went to school every day and that he had not used a stick or crutch for several months. The motion in the hip was free and of normal extent, and there was no pain. There was about 1¾ inches shortening in the limb.

From the above description it will be seen that although the operation is better adapted for ankylosis of the hip other than that due to tuberculous arthritis, it might nevertheless be employed with advantage in those cases in which the ankylosis has occurred with the greater part of the head of the femur still present and free from disease. When, on the other hand, the head as well as the greater part of the neck has been destroyed, or when foci of tubercle still exist, it would probably be better not to attempt Murphy's operation. How far it is advisable in the future to adopt Murphy's arthroplastic principle with the special object of obtaining a movable joint after excision must be left to future experience to settle. The method would seem to be specially adapted for primary synovial cases, and for cases in which there is but little osseous disease of the femur.

OPERATIONS FOR ABSCESSES AND SINUSES, THE RESULT OF TUBERCULOUS DISEASE OF THE HIP-JOINT

Although these complications are frequently met with, their treatment is so much a matter of general principles that the operative details need not be fully discussed in a work of this description.

Should a small abscess form with the patient going about in the early stage of the disease, it will occasionally absorb if the limb be kept at rest. If, on the other hand, it should continue to enlarge it must be opened and curetted. While there are some cases in which the joint may be left untouched, it is usually wiser to make the incision of such a size and so to place it that the joint may be investigated in order that a definite decision may be come to as to whether radical measures should be proceeded with. When the abscess is situated posteriorly, excision may be proceeded with by Kocher's method.

to its normal position by extension and adduction of the thigh. It was found to fit accurately and it could not be dislocated by any of the ordinary motions of moderate degree. The free border of the fascial flap, which projected from the margin of the acetabulum, was now sutured with interrupted catgut sutures to the periosteum, and the capsule was attached to the neck of the femur. The flap was amply large so that it completely covered the head and came well up on to the neck without tension. (I consider this a very important point ; the entire articular surfaces of the

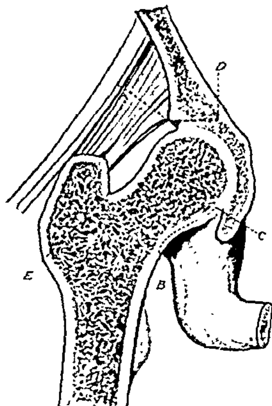


Fig. 61. Ankylosis of the Hip-joint. Shows bony union between the head of the femur and the acetabulum. In separating the bones the chisel was entered at the points c and d. (*After Murphy.*)

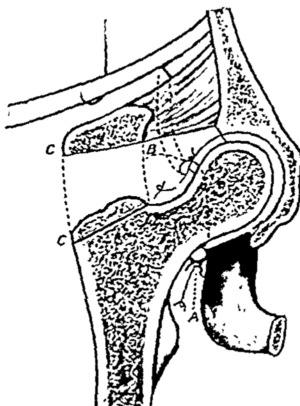


Fig. 62. Ankylosis of the Hip-joint. c, c, great trochanter with its attached muscles turned upward. The fascial flap surrounds the head of the femur and is sutured to the capsule at a and b. (*After Murphy.*)

bones must be covered by fascia if we are to expect a good functional result, and the same applies to other joints.) The great trochanter was brought down to its normal position and accurately secured with two aluminium-bronze wire sutures. The skin flap was replaced and sutured with horsehair. No drainage was used. Because of the contraction of the flexors and abductors of the thigh, extension and abduction were limited and were accomplished only by the use of considerable force. This contraction was overcome by forcibly stretching the muscles, using the thigh as a lever, and at the same time exerting with the edge of the

TUBERCULOUS DISEASE OF THE SACRO-ILIAC JOINT

The disease is generally secondary to a focus in the sacrum or ilium, and in adults it is frequently accompanied by pulmonary tuberculosis. In children it is often secondary to disease in the lower lumbar spine.

Skiagraphy is of the greatest assistance to the surgeon in enabling him to localize the situation of the bone focus at a comparatively early stage of the disease. In the absence of advanced pulmonary tuberculosis, the operation should be advised, and, if possible, it should be performed before suppuration occurs.

Operation. The joint is best exposed by a semilunar incision placed internal to the articulation. The size of the incision will, of course, depend on the extent of the disease. After retracting the flap outwards, the periosteum is incised over the back part of the crest of the ilium, while below the level of the posterior superior spine the knife is carried down to the back of the sacrum between the origin of the gluteus maximus and the lumbar aponeurosis. The posterior fibres of the gluteus medius, the upper fibres of origin of the gluteus maximus, and the upper part of the great sacro-sciatic ligament and the subjacent periosteum are separated from their attachments and retracted well outwards. The inner flap, consisting of the lower part of the erector spinæ, is detached inwards. The posterior superior and posterior inferior spines of the ilium are removed with a chisel. If the disease be limited to the ilium, little more requires to be done except perhaps to scrape and clip away some disease which has invaded the posterior ligament and adjacent soft parts. If, on the other hand, the sacrum be involved and the joint more extensively diseased, more of the ilium may have to be removed before sufficient access can be got. The strong interosseous ligament, along with the diseased portion of the sacrum, is then removed with a chisel or gouge. If possible, the periosteum and ligaments covering the anterior aspect of the joint should be left intact, and the important structures immediately in front of it, namely, the internal iliac vessels, the ureter, and the lumbo-sacral cord, must be kept in mind.

An abscess or sinus confined to the posterior aspect of the joint is easily dealt with, but considerable difficulty may arise in following up suppurating tracks and collections of pus which have burrowed into the pelvis. In the presence of such complications, in order that free through and through drainage may be established, it will generally be necessary to make a counter-opening either in the iliac region, the buttock, the upper and inner aspect of the thigh, or the perineum, according to the route taken by the abscess.

Sometimes after opening an anterior abscess along the inner border of the sartorius a suppurating track may be followed underneath the iliacus to its origin from a small primary bone focus at the margin of the acetabulum close to the anterior inferior spine of the ilium. In such a case it not infrequently suffices to curette the bone without incising the capsule. When, however, the abscess communicates with the joint, the latter should be explored. In other cases the abscess is confined within the capsule of the joint, and is then treated either by simple arthrotomy or by excision, according to the extent of the disease. In cases where excision was deemed advisable the writer was formerly in the habit of employing Barker's method; more recently, however, he has abandoned it in favour of the posterior operation.

In the case of a large abscess extending down the thigh under the fascia lata, it is sometimes advisable, on account of the debilitated state of the patient, to defer the excision until some time after the abscess has been dealt with. Should the general condition of the patient seem equal to it, however, it is better to proceed at once to excision; if the disease in the joint be left it only serves to reinfect the abscess cavity.

The incision used to excise the joint should be prolonged down the thigh sufficiently to allow the whole abscess cavity to be laid open and thoroughly cleaned out. The whole wound should be sutured, except at its lowest part, where a rubber or gauze drain should be introduced, and a second drain should be introduced opposite, and down to, the joint. A counter-opening may be made if necessary. The shock, although considerable, may be counteracted by the introduction of large quantities of normal saline into the rectum by the drop method introduced by Murphy.

After opening and removing the tubercular lining of the abscess by curetting, followed by vigorous scrubbing out with dry gauze, it is customary to introduce some antiseptic with the object of destroying the few bacilli which have almost certainly escaped removal. A 10% emulsion of iodoform and glycerine has been most commonly employed for this purpose. More recently Murphy has made use of a 2% solution of formalin in glycerine. The writer uses the sublimated iodoform-bismuth paste in the proportion of one part of the former to two or three of the latter, according to the size of the abscess.

While the presence of sinuses renders the results of excision less favourable on account of their liability to set up a general infection of the wound, their presence should not *per se* be regarded as contra-indicating excision; indeed their persistence is often an argument in favour of excision, as in the majority of cases it is only by removing the joint lesion that they can be got to heal.

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After-treatment. The after-treatment consists in prolonged recumbency, as much as possible in the open air. To ensure rest sand-bags may be used, or the patient may be fixed to a Bradford's bed-frame.

Results. The results are often very unsatisfactory; the patient not infrequently dies of meningitis or general tuberculosis. Sinuses are very liable to persist indefinitely, and to lead to waxy disease.

SECTION II

OPERATIONS UPON THE LIPS FACE AND JAWS

PART I

OPERATIONS FOR HARE-LIP AND CLEFT-PALATE

BY

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CHAPTER I

THE DEVELOPMENT OF THE LIP AND PALATE

A SHORT account of the development of the lip, mouth, and palate will help to explain the occurrence of the defects in question. Early in intra-uterine life the buccal and nasal fossæ form one common chamber; at the eighth week the maxillary processes grow horizontally inwards from either side of this chamber to form a partition between the fossæ, and if these processes fail to meet, the gap in the palate might be expected to be in the exact median line. The front portion of the hard palate, however, is not developed from these processes, but, with the anterior part of the nasal septum and the median part of the upper lip, is derived from a column of mesoblastic tissue descending from the frontal region. And this mass of tissue contains the intermaxillary bone. Thus, the roof of the mouth is formed by the fusion of the maxillary processes with each other in the middle line, and with the descending nasal process in front. A cleft of the soft and of the back of the hard palate is, therefore, in the exact median line; but towards the front it passes outwards and forwards between the border of the intermaxillary bone and the front of the maxillary processes, the line being Y-shaped. When failure of union between the median and the lateral processes affects the integumental parts as well as the osseous, the cleft-palate coexists with a double hare-lip. The intermaxillary bone, the vertical plate of the ethmoid, and the vomer are developed from the fronto-nasal process, and by the third month they should be united.

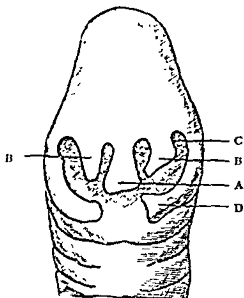


FIG. 63. EMBRYO OF THREE WEEKS. Showing: A, fronto-nasal process, descending between the superior maxillary plates B, B; C, eye; D, inferior maxillary plate.

On the borders of the fronto-nasal process are the superior maxillary processes (see Fig. 63, B, B), which blend with the fronto-nasal bud to

complete the upper lip. Thus, the fissure of the imperfectly developed lip is where the descending process has missed blending with the lateral fold. The fissures of a double hare-lip represent the notches which existed between the fronto-nasal and the maxillary buds of embryonic tissue. When the osseous tissues in the deep parts of the processes join, whilst the superficial parts do not, hare-lip exists without a palatine cleft.

For some reason which is not understood, single hare-lip is more often upon the left side. Hare-lip may vary in degree from a mere notch to a wide fissure extending up into the nostril. In some cases there is a notch beneath each nostril, or a fissure into one nostril and a notch beneath the other. Or there may be a fissure into each nostril, with, perhaps, isolation of the prolabium and the incisive bones, which, high up and alone, may be attached to the tip of the nasal septum. It is unlikely that maternal impressions have anything to do with the causation of hare-lip or cleft-palate. As a rule, the supposed 'fright' or shock to which it is attributed occurred after the lips were developed—after the ninth week, that is to say.

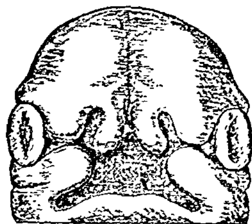


FIG. 64. EMBRYO SHOWING MEDIAN NOTCH IN FRONTO-NASAL BUD.

The fronto-nasal bud is marked by a median notch, and if this persists a median hare-lip may result. I have seen only one such case. If the descending frontal process misses its way it may join one of the lateral portions of the lip, or, as already noted, the tip of the nasal septum.

It often happens in cleft-palate that the median fissure runs outwards and forwards on one side only—like a letter Y with one arm broken off; it is generally associated with a single hare-lip. As a rule, in cases of cleft-palate and hare-lip that portion of the maxillary arch which is attached to the septum contains the central incisors, the lateral incisors being altogether wanting; sometimes, but rarely, it contains the four incisors, the palatine fissure in those cases passing close in front of the canine tooth. If the cleft be on one side only, the maxillary arch will probably contain three incisor germs, the absent tooth being on the side of the palatine cleft, as will be shortly explained.

For the most part, Albrecht's scheme and theory of the development of cleft-palate and the eruption of teeth therewith have been accepted

in this country, but subsequent investigation has not proved them trustworthy. Albrecht has mixed up the question of ossification of the maxillæ with the eruption of the teeth, but these questions bear no relationship to each other, the bones being mesoblastic tissue and the teeth being epithelial. The teeth are formed from buds of the deep layer of the buccal epithelium, which, growing downwards, become surrounded in due course by the bony alveoli of the palatal arch. The buds for the central incisors pass into the premaxilla: those for the canine tooth and for the molars pass into the maxillary process. The bud for the lateral incisor happens to be placed just over the gap which exists between the premaxilla (mesial nasal process) and the maxillary process, and in the case of a cleft-palate it is, consequently, apt to disappear. It may, however, happen to work its way into the premaxilla or, perhaps, into the maxillary process, or (and this is more than likely) it may find no resting-place and may fail to be developed.

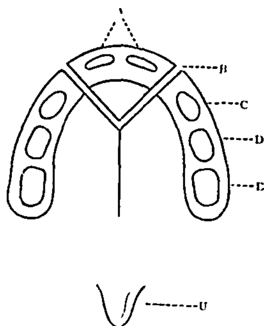


FIG. 65. SCHEME OF THE PALATINE CLEFT AND THE DENTAL SACS. A, Fronto-nasal bud containing central incisors; B, Cleft between the fronto-nasal bud and the maxillary process taking the place of the lateral incisor; C, Canine; D, E, Molars; U, Uvula.

Dr. Keith, the Conservator of the Museum of the Royal College of Surgeons, has shown me various anatomical preparations in which the bud for the lateral incisor is attached to the very front of the maxillary process, standing forwards from it into the cleft as a semi-isolated papule, and other specimens in which it is projecting into the cleft from the premaxillary mass. In certain rare examples the bud has evidently been split, as there is a small lateral incisor on each side of the cleft.

In an interesting paper by Mr. Clement Lucas in the *British Journal of Children's Diseases* (November, 1904), it has been shown that congenital absence of an upper lateral incisor, or an imperfect development of that tooth in a parent, is apt to be a forerunner of hare-lip or cleft-palate in the offspring. Similarly, one may find a small lateral incisor behind the fissure of a hare-lip, suggesting that the child has narrowly escaped being the subject also of a cleft-palate. Mr. Lucas's paper is well worthy of being referred to.

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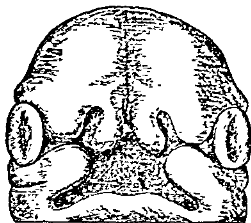


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For the most part, Albrecht's scheme and theory of the development of cleft-palate and the eruption of teeth therewith have been accepted

deal of the free border of the smaller side of the lip, whilst from the other side a bold flap is cut as is shown in Fig. 67, C D E. This flap is afterwards brought across to the denuded border of the lip upon the other side. Of its thickest part a prolabium is formed, whilst that part which before had been the mucous border of the vertical cleft becomes the horizontal border all along the rest of the lip. The piece thus brought across is a thick, wedge-shaped flap, which is boldly tilted down so as to leave an angular space into which the opposite side of the lip, already vivified, may be dove-tailed.

The right side of the lip having had its mucous membrane carefully pared off up to the curved line C D E (Fig. 68), the lateral halves of the lip are drawn together in the middle line. When the left half of the

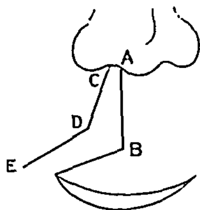


FIG. 68. THE OPERATION FOR HARE-LIP. *Third stage.* The mucous border has been removed from the right side and a flap cut from the left side.

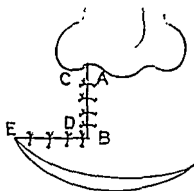


FIG. 69. THE OPERATION FOR HARE-LIP. *Final stage.* The flap from the left side has been adjusted along the right half of the lip.

lip has been thus brought to the middle line, the incision A B, which had been made obliquely into the lip (Fig. 66), becomes vertical, the thick flap, which had previously been vertical, becoming horizontal and ready to form the mucous border of the restored lip. The right side of the lip being drawn inwards, some of its freshened border, C D, is placed vertically, whilst the rest of it, D E, becomes horizontal, and to it the deflected flap from the left half of the lip is adjusted, the middle part, D, being fitted into the angle on the left side, as at B in Fig. 69. The mucous membrane must be entirely removed in order that primary union may be complete, and it should be removed from around the whole thickness of the lip. Not a particle of the skin, however, should be sacrificed.

The flap thus described is not the same as in Mirault's operation. His method entailed the cutting with a pair of scissors merely of a ¼-inch flap from the lower border of the lip which was to be arranged to form a normal prominence for the lip, as a sort of pedicle.

CHAPTER II

OPERATIONS FOR HARE-LIP

Indications. As is shown later on in this article, if a child has a hare-lip and a cleft-palate, the palate should be operated on before the lip. But if an infant has a hare-lip and no cleft-palate, the sooner the lip is operated on the better; it may be done any time after the tenth day—and earlier still, if need be—but it should not be done without an anæsthetic, for which purpose chloroform answers best.

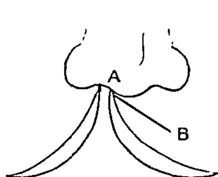


Fig. 66. The Operation for Hare-lip. *First stage.* The mucous border of the right side of the gap is to be peeled off, and the flap on the left side which is set free by the incision A B is to be brought across below the right side of the lip.

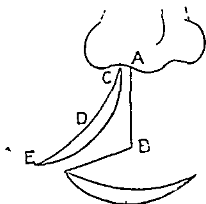


Fig. 67. The Operation for Hare-lip. *Second stage.* The left side of the lip being drawn well across, the incision A B becomes vertical, and a full prolabium is obtained.

Operation. One of the most important points in the operation is to detach the lip and cheek freely, so that the vivified edges may meet across the gap without any tension. The bleeding vessels can be caught by clip-forceps, and all blood thus prevented from entering the mouth.

After the labial flaps have been fully detached, the incisions are made for obtaining the raw edges. By one of the old methods of operating the mucous membrane was dissected from each side of the gap, and, thus, when the raw surfaces were drawn together, an unsightly notch was apt to be seen on the free border of the lip. The border of the lip should be vivified by a very sharp scalpel; an old scalpel which has been worn thin by grinding does excellently for the purpose. The mucous membrane is peeled from one side of the cleft and from along a good

of the vertical wound may also be ready for removal. A gauze and collodion dressing is applied as before, and next day, or the next day but one, the wound should be dressed again, a few more of the anterior stitches being removed, the posterior stitches still being left. Thus, within four or five days all the visible sutures are removed, those at the tail end of the flap and at the free border of the lip being last taken out. For ten days or a fortnight after this the lip must be kept from disturbance by gauze and collodion or by waterproof strapping. If the surgeon does not think it necessary to have chloroform administered for the dressings, the nurse should be sitting in a chair opposite to him with the child lying on her lap, whilst the surgeon grips its head firmly between his knees, so as to keep it quite steady.

If the case be one in which the intermaxillary bone and the prolabium have been sacrificed and the new lip is very small, the removal of a wedge-shaped piece from the middle of the lower lip may improve the appearance, a prominent lower lip being very unsightly.



Fig. 70. Operation for Double Hare-lip. A, Prolabium with borders denuded; B, Right side of lip denuded and flap brought down; C, Left side of lip denuded; D, Flap brought down and vivified on lower border, ready for being tucked round between the right side of the prolabium and the right labial flap.

Double hare-lip. If in the case of a double hare-lip the prolabium can be used, it may need to be lowered somewhat before it can be made available for the new lip. This being done, the mucous membrane should be thinly and cleanly dissected off its borders, and the two sides of the lip should be arranged for blending with it. Probably one side of the lip is larger than the other; this, therefore, should be chosen to build up the mid-part and the lower border of the new lip. A flap is also cut from the other side of the lip, but before this is done, the mucous membrane is peeled from its free border, so that the flap can be dove-tailed in between the vivified border of the median bud and the fresh-cut surface of the other flap, as shown in Fig. 70.

If this flap, which is denuded on both its upper and its lower surfaces, be long enough, it may be bent around the border of the median bud towards the opposite side, lying between the median bud and the large flap, and in this position it is duly secured by a few deep sutures, as already described, and by superficial ones of horsehair.

Sometimes the closure of the cleft in the lip causes a great difficulty of breathing, for whereas the air-way had been unusually free, the infant is subsequently obliged to breathe only through the nose and mouth,

Sutures. For the thorough adjustment of the flaps stitches should be inserted not only down the front of the lip, but also on the dental aspect, and some of them should be placed very deeply, so as to prevent the halves of the orbicularis and the associated muscles dragging upon the wound. Prepared horsehair may be used for adjusting the edges of the skin and for securing the transplanted flap along the opposite half of the lip; silk is not suitable as it swells and becomes septic. The vivified surfaces must be kept in close contact by passing some of the posterior stitches deeply and boldly with a curved needle, the needle being brought almost through to the skin, but just missing it; these stitches are of great use in steadying the flaps. The old-fashioned hare-lip pins should never be used; they are not needed even in cases of the worst kind. The spots at which they traversed the skin were apt to be permanently marked by white scar-tissue. A great advantage of the deep sutures at the dental aspect of the lip is that they leave no mark; they also arrest bleeding, and they adjust the surfaces and edges of the wound so well, that possibly only a few stitches may be required for the front. None of the stitches should be tied very tight or they will cut their way out by ulceration; they are wanted merely to hold the surfaces gently together. Their ends should be left about ¼ inch long, so that they can be easily seized by the forceps when the time comes for their removal.

If, as often happens, the nostril be wide and flat, it should be made shapely, and fixed in the approved position; some of its cartilaginous ring may have to be cut away so as to reduce its size and round it off. It may need also to be separated from the bone, and it may be advisable to hitch up its lower and outer part by a silver-wire suture. In some cases it is well to turn up the mucous membrane from the projecting ring of the nostril, and then, having shaved off a thickish slice of the cartilage, to bring down again and suture the membrane.

Dressings. When the last stitch has been inserted, and the face has been washed and thoroughly dried, the assistant should purse up the lip with the finger and thumb whilst the surgeon applies a dressing of gauze dipped in collodion and long enough to reach well on to the cheeks. Next day this had better be removed, and it is often advisable to do this first dressing under chloroform. The nurse gently holds the slack of the cheeks towards the middle line, and the surgeon peels off the gauze by pulling the ends *inwards*, being careful not to drag upon the sutures; then, when the part has been cleaned, he may decide to remove, perhaps, every other stitch, as the edges of the wound are closely adhering. If a thick stitch has been deeply inserted from the front, it certainly ought to be removed, lest it should leave a scar. The sutures at the top end

CHAPTER III

OPERATIONS FOR CLEFT-PALATE

ON THE EMPLOYMENT OF PRESSURE IN THE TREATMENT OF CLEFT-PALATE

In the *Medical Record* of Australia for June 15, 1861 (Melbourne), is an article by the editor, Dr. Reeves, which is apparently the first recommendation of the pressure-method of dealing with cleft-palate. Dr. Reeves was led to try it on the dead body of a child who had died three weeks after birth. The fissure was complete, and large enough to admit the end of the little finger. By means of a pair of clamps the sides of the fissure were readily brought together. The gums of the upper jaw were then found to be within those of the lower jaw, but Dr. Reeves formed the opinion that Nature would be able to remedy that defect as the living child grew up. Dr. Reeves insisted that *the operation for cleft-palate should be performed as early as possible after birth, when the bones were in their softest condition.* He suggested that the edges of the fissure should be pared, and that by the padded blades of the horseshoe-shaped clamp the maxillary bones should be slowly brought together. He does not appear to have performed this operation on a living infant, and his suggestion seems to have been lost sight of, but if, as is probable, this treatment of congenital cleft-palate is to be adopted, it is right that his suggestion should have due acknowledgment.

It was through the published works of Dr. Brophy of Chicago that my attention was first called to the method, and I have every reason for speaking well of it.

Time for operating. Inasmuch as cleft-palate is an arrested development, the gap ought to be closed at the earliest possible moment, and the most favourable time for operating upon it is between the age of two weeks and three months. Brophy is probably right in affirming that at this age there is less shock from the operation because the nervous system is in a rudimentary condition; and, certainly, the sooner the muscles of the soft palate are enabled to work with a definite scheme of vocalization in view the more perfect will the voice eventually become. It is a generally recognized and disappointing fact that when operation is undertaken at a later age, though the gap in the palate may be completely closed, only a slight improvement in vocalization may take

and the nostrils are, perhaps, a good deal blocked by dry blood and mucus. In these circumstances the nurse has to guard the child from the risk of suffocation by gently depressing the lower lip. If the difficulty of breathing be very marked, the surgeon may feel inclined to pass a suture through the back of the lower lip and bring the two ends round the border of the lip, fixing them to the chin by a piece of waterproof strapping. The sucking in of the lower lip and the difficulty of breathing are thus done away with, and as there is no tension on the suture it does not hurt the lip.

It sometimes happens that the lower border of the lip is marked by a notch, either with or without an operation having been performed; this may be effaced by making a horizontal incision into the substance of the lip a little above the notch, and then closing the wound in the vertical manner. This operation is on the principle which is adopted for widening a short constriction in the alimentary canal, an incision being made in the length of the bowel and closed at right angles to it.

If after operating on a hare-lip the surgeon sees in a day or two that the line of sutures is 'breaking down', and that there is no longer any chance of obtaining primary union, he may still look for a good result by the fusing together of the two layers of granulation tissue. If, therefore, the flaps fall apart, the sutures should be removed, and the lip should be bathed in warm boric lotion and covered with wet boracic gauze. So long as the tissues are acutely inflamed, nothing can, of course, be done with a view to bringing the parts together again; but as soon as the inflammation has subsided, and healthy granulations begin to cover the raw surfaces, the sides of the lip should be readjusted by gauze and collodion, or by strips of waterproof strapping. In this way a very excellent result may often be obtained for an operation which had at one time threatened a complete failure—a good example of healing by granulation.

prospects of securing a natural voice being thereby greatly increased. And just as the approximation of the hinder part of the maxillary processes gives assistance in the repair of the soft palate, so does the approximation of their anterior part simplify the subsequent operation on the hare-lip.

The operation is begun by raising the cheek. A strong needle on a handle is then thrust through the maxilla just behind the malar process of the superior maxilla, and above the level of the horizontal process of the palate bone. This needle carries a thick silk pilot-suture through to the cleft, and its loop is pulled down towards the mouth. Then the needle is similarly passed through the opposite maxilla, the loop being brought down as before. This second loop is passed through the first, which, being drawn upon, is made to bring the second loop out through the maxilla and across the nasal fossa. The suture then is horizontal. The sharply-bent end of a thick silver wire is then hooked on to this loop, and, by pulling on the latter, the wire is made to take its place. The wire suture thus lies above the horizontal processes of the palate bones, where it can be seen through the cleft. Similarly, a wire suture is taken through the maxillæ above the front part of the cleft. Two small, oblong leaden plates, with a hole drilled near each end, are then laid along the outside of the right maxilla, under the cheek, the end of the hinder wire being passed through the posterior hole and the end of the front wire through the anterior hole. The right ends of the wires are then twisted together from left to right, the plates being closely applied against the maxilla, and after this the twisted ends of the wires are pressed flat. The ends of the wires under the left cheek are then similarly treated, and as they are being twisted up the maxillæ are firmly squeezed together. If, however, they are too solidly fixed to be moved towards each other, the bones themselves must be divided by a scalpel sufficiently to enable the surgeon to force their palatine processes into the middle line. In this way the width of the gap in the lip is greatly reduced and the lateral halves of the soft palate come together. Fine sutures are then passed through the freshened borders of the entire cleft. After the maxillæ have been thrust together, the

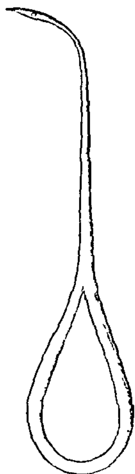


FIG. 71. NEEDLE FOR MAXILLARY SUTURING.

place. Still, if a new-born infant be badly nourished and ill-suited for the struggle for existence, it would be wrong to submit him to any operation. He should be wrapped in wool, rubbed daily with cod-liver oil, and brought into a satisfactory state of health before the cleft is dealt with.

Once more, therefore, if it be admitted that distinct vocalization depends upon the anatomical integrity of the soft palate, the earlier that a cleft is repaired the better: it should certainly be done before the hare-lip is operated on.

Some surgeons are still in favour of postponing operation upon the palate until the child has passed the age of infancy. But the earlier the cleft is closed the better will be the voice, and if the hare-lip be dealt with before the palate the surgeon has less room for operating on the palate. One argument raised in favour of operating first on the lip is that the mother may not be subjected to the constant grief of seeing her child's serious disfigurement. But if it be explained to the mother that the delay in operating on the lip is advised in the child's interest, she will be likely to take a reasonable view of the question. The physical well-being of the child must not be sacrificed to the sentiment of the mother. Certain it is that if the lip were closed the infant would still have to be brought up by a large-teat bottle or by spoon-feeding. It is further advised by some who are in favour of doing the lip-operation first that if, when the child has attained the age of two years or so and the surgeon is about to deal with the palate, the mouth is so small that there is not room for the gag, the lip can be divided so as to get rid of that difficulty. But those who have made themselves familiar with the operation on the palate by thrusting the maxillæ together, will be able to appreciate the great help which is given in the subsequent repair of the lip when the maxillæ and their labial coverings have been brought together. It is all in favour of a good appearance being given to the hare-lip if the cleft-palate be dealt with by first approaching the maxillæ to each other.

Operation. The operation by pressure consists in thrusting the two superior maxillary bones together and then adjusting with sutures the vivified edges of the cleft. Brophy maintains that in cleft-palate cases the roof of the mouth is excessive in diameter by just the width of the cleft, and that after the maxillæ have been thrust together and the palatine processes united, the development of the alveolar processes becomes normal, and that when the teeth of the superior maxillæ which have been shifted inwards by the radical operation are erupted they will exactly meet those of the lower jaw One of the important features of this operation is that the halves of the soft palate so brought together can be sutured without interference with the muscles of the palate, the

the surgeon is likely to use them. They should not be placed in any lotion. The most convenient anæsthetic is chloroform, given on a flannel mask, which, later on, is changed for a Junker's apparatus. The chloroformist should not be called upon to help in the operative work; he has enough to occupy his thoughts and his hands. The child ought to be only just 'under'; the anæsthetist should be able to feel that at any moment, if need be, he could wake him up. The operator should not object to the child making purposeless movements from time to time, as he then knows that his patient is 'upon the safe side'. If the breathing becomes embarrassed the surgeon should stop and see if a change in the position of the head, or of the gag, may improve matters. The best position for the child during the operation is upon the back, with the head hanging over the end of the table, so that the blood may escape by the mouth or nostrils. This position, however, sometimes hinders the breathing; still, it should be tried in every case. It often happens that after the operation the child vomits blood; and sometimes when there has been little or no vomiting, the first motion passed after the operation is tarry, some blood having found its way into the alimentary canal in spite of the child having been kept inverted during the operation.

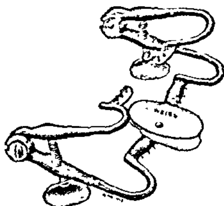


FIG. 73. KEYLESS GAG FOR CLEFT-PALATE OPERATIONS. The spikes prevent slipping even on a toothless gum.

The gag which I advise is a modification of Sir Thomas Smith's, as shown in Fig. 73.

The raspatories, which should be slender, are made of steel, and about eight inches long, with the ends in different curves for suitable or variously pitched arches. The ordinary steel aneurysm needle makes a very useful raspatory. The swabs can be made of tufts of absorbent cotton-wool loosely tied up in gauze. They should vary in size from a cherry to a plum. They should be used dry.

The most convenient needle for a cleft-palate operation is the tubular one, with a reel containing an abundant supply of fine silver wire. At the end of the needle is an arrangement by which one of the curved, sharp points can be rigidly fixed; the wire is made to run through it by the movement of a small wheel upon the handle. The points are of various curves and sizes, and, being round, do not cut the flaps (see Fig. 74).

As already stated, the best time for operating on a cleft-palate is within the first few weeks after birth. But it may happen that the child has passed that age when he is brought for operation. Assuming,

wires extending between the leaden plates have to be tightened up. These wires and plates are not disturbed for three or four weeks. Some superficial ulceration may take place beneath or against the borders of the plates, but it is not of importance. The wires and plates may be removed after about the third week.

When the prolabium and the incisive bone are so advanced and isolated that the surgeon is unable to make use of them, he must remove them; but it should always be his endeavour to save them. Sometimes the projection can be thrust into position only by bending down the tip of the nose, and when it has become firmly attached in its new position the connexion with the nose may be divided; or it may be found that after the removal of a triangular piece from the septum the prolabium comes easily into position.

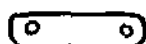


FIG. 72. LEAD PLATE FOR SUPPORTING WIRE SUTURES. Actual size.

Mr. Arbuthnot Lane is also an advocate of the palate being operated on before the lip, and he prefers to operate on the palate when the infant is five weeks old. He raises a flap of muco-periosteum, and, turning it over like a page of a book, tucks its free border in between the bone and the muco-periosteum of the other side, having previously made ready the groove for its reception by detaching the muco-periosteum for about a quarter of an inch. The soft palate he treats in like manner, splitting it and turning it over, and suturing it to the other side, which he has already vivified by a little splitting and unfolding. The splitting and suturing of the flaps are done with special knives and needles.

STAPHYLORRHAPHY AFTER INFANCY

Preparation. In the case of a child with cleft-palate who has passed beyond infancy, the sooner that the operation is undertaken the better. But before this is done the child must be duly prepared. Carious teeth should be extracted, or cleaned and filled; enlarged tonsils should be amputated, and adenoids cleared away, and the mouth made as healthy as possible. And it may be well for the nurse to wash the mouth with a hand-spray of some mild antiseptic, so that after the operation, when its use is highly desirable, the child may not be alarmed by it.

Operation. The operating-table should be between 3½ and 4 feet high (inclusive of a firm mattress), and quite narrow, so that the assistant may also be able to see into the mouth. The instruments should be laid on another table of the same height, and should be arranged upon an aseptic cloth from left to right in the order in which

the surgeon is likely to use them. They should not be placed in any lotion. The most convenient anæsthetic is chloroform, given on a flannel mask, which, later on, is changed for a Junker's apparatus. The chloroformist should not be called upon to help in the operative work; he has enough to occupy his thoughts and his hands. The child ought to be only just 'under'; the anæsthetist should be able to feel that at any moment, if need be, he could wake him up. The operator should not object to the child making purposeless movements from time to time, as he then knows that his patient is 'upon the safe side'. If the breathing becomes embarrassed the surgeon should stop and see if a change in the position of the head, or of the gag, may improve matters. The best position for the child during the operation is upon the back, with the head hanging over the end of the table, so that the blood may escape by the mouth or nostrils. This position, however, sometimes hinders the breathing; still, it should be tried in every case. It often happens that after the operation the child vomits blood; and sometimes when there has been little or no vomiting, the first motion passed after the operation is tarry, some blood having found its way into the alimentary canal in spite of the child having been kept inverted during the operation.

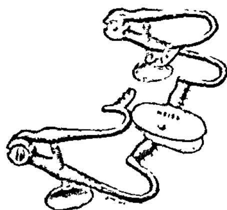


Fig. 73. Keyless Gag for Cleft-palate Operations. The spikes prevent slipping even on a toothless gum.

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The most convenient needle for a cleft-palate operation is the tubular one, with a reel containing an abundant supply of fine silver wire. At the end of the needle is an arrangement by which one of the curved, sharp points can be rigidly fixed; the wire is made to run through it by the movement of a small wheel upon the handle. The points are of various curves and sizes, and, being round, do not cut the flaps (see Fig. 74).

As already stated, the best time for operating on a cleft-palate is within the first few weeks after birth. But it may happen that the child has passed that age when he is brought for operation. Assuming,

then, that he is in a good state of health and that his mouth is clean, he is placed upon the table for operation. The child being under chloroform, the surgeon passes a long suture through the tip of the tongue and gently pulls it forward, so that when the gag is fixed the tongue may not block the air-way.

A strip of mucous membrane having been removed from each side of the cleft, incisions are made close near the teeth, passing down to the bone, as shown in Fig. 75.

Some children bleed much more than others. Bleeding may, as a rule, be quickly stopped by firm pressure with a dry swab. The closer that these incisions are made to the teeth the less the chance of wounding branches of the descending palatine artery, the broader will be the flaps, and the less the likelihood of their blood-supply being seriously interfered with. Then, by raspatories introduced through these incisions, the muco-periosteum is detached from the hard palate. The higher the pitch of the roof the greater is the probability of the flaps being brought together without tension. Indeed, in some cases of high roofs, the flaps are so slack that not only *their bare edges*, but some of their raw upper surfaces can be brought together, which much increases the chance of securing prompt union. But they do not often come together without some tension; this is because they are continuous with the velum which is firmly connected with the hard palate. In the velum is an aponeurosis which, attached to the border of the hard palate, receives part of the insertion of the tensor palati and the levator palati, and this aponeurosis must be detached before the velum can

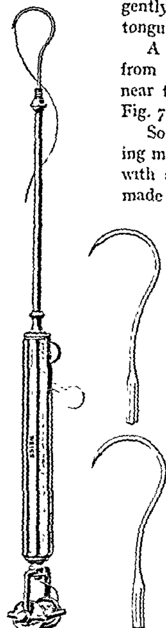


FIG. 74. MECHANICAL NEEDLES FOR CLEFT-PALATE OPERATIONS.

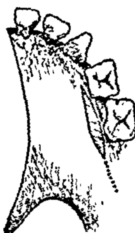


FIG. 75. THE INCISION MADE NEAR THE ALVEOLAR PROCESS THROUGH WHICH THE FLAP OF MUCO-PERIOSTEUM IS DETACHED.

be moved inwards. Success largely depends upon the thoroughness with which the disconnexion of the aponeurosis is made. It is best done by passing one blade of a pair of scissors (bent on the flat almost to a right angle) between the detached muco-periosteum and the under surface of the back of the hard palate, and the other through the cleft and over the back of the velum, as shown in Fig. 76. Thus between the blades are placed the mucous membrane which is continued from the floor of the nasal fossa and the aponeurosis of the soft palate, together with that part of the tendon of the tensor palati which is inserted into the palate bone. When this scissor-cut has been made, the muco-periosteum and velum hang loose, and the flaps are ready for suturing. When the surgeon has passed the sutures through the flaps, he may find so much tension upon the edges of the flaps that he deems it best to twist up the sutures only loosely. Later, when he has increased the length of the lateral incisions, he may tighten them up permanently with torsion-forceps. And so that he may know in which way he should twist to tighten, he should make it a rule always to twist from left to right, as in dealing cards. If it be found that, as the flaps are drawn together, there is still so much tension that, if the silver sutures were fully twisted up, either the wire would break or cut its way through the flap, he must prolong the incisions backwards well into the halves of the velum, as is indicated by the dotted line on Fig. 75. The incisions thus made sever the aponeurotic insertion of the tensor palati and the chief part of the insertion of the levator palati.

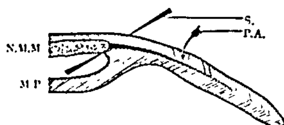


FIG. 76. DIAGRAMMATIC REPRESENTATION OF THE JUNCTION OF THE HARD AND THE SOFT PALATE. M.P., Muco-periosteum detached from the hard palate; N.M.M., Mucous membrane passing on to the floor of the nares; P.A., Aponeurosis of the soft palate; S, Blade of curved scissors about to cut through the aponeurosis and the membrane.

Experience shows that however wide a cleft of the hard and soft palate may be, it is advisable to operate upon the entire cleft at one time rather than divide the operation into two parts, one for the hard palate and one for the soft In certain cases of wide cleft of the hard palate of a grown child, the bone may be cut about ¼ inch from the gap on each side and the flaps of bone and mucous membrane shifted together, the vivified edges being adjusted by sutures. After the operation, and before the gag is removed, it is a good plan (the head still being dependent) to send several syringefuls of warm water up the nostrils. This clears away all clots and gives a free air-way.

After-treatment. When this is all done, and the gag and the tongue suture are removed, the child should be so placed that the saliva, blood, and mucus may dribble out of the mouth without having the chance of entering the larynx or œsophagus. In the case of an infant, the nurse had better keep him in her arms for a while, with the face directed downwards. But if he is too heavy to be thus nursed, he should be put in the half-sitting position, and partly turned to one side, with the head bent down, so that the discharges may dribble into a towel. If the child be collapsed it may be necessary to keep his head low and to give an enema of hot water with a little brandy. He should have nothing by the mouth for several hours, but when the nausea has apparently passed off, small quantities of beef jelly may be given in a teaspoon: jelly slips down easily and is preferable to milk; it does not form curds in the stomach and it is easily absorbed. This should be supplemented by rectal feeding. In the course of a day or so a little sweetened orange-juice, pulped strawberries or peaches, chicken or meat which has been run through a fine sieve, bread and milk, or soft custard pudding may be given. Fresh, home-made beef jelly, broth, and all other foods for children are far better than the various meat essences, extracts, and juices supplied by the shops.

Possibly the child will allow the nurse to use a mild antiseptic spray for the mouth, but it should not be persisted in if it frightens him. As regards the fluid for irrigation, sanitas and water, a very mild solution of Condy's fluid, or a solution of boracic acid with glycerine and eau-de-Cologne, answers well. It is unnecessary for the surgeon to remove the sutures; they will quietly ulcerate their way out. This refers, of course, only to the fine wire and horsehair sutures, not to those more solid ones of silver wire which pass through the maxillæ and the lead plates in the radical operation of infancy as described on p. 146.

Complications. If, by chance, severe hæmorrhage should set in, the gag must be reintroduced and search made for the bleeding vessel. All clots should be removed, and the mouth and naso-pharynx should be syringed out with warm water, the head being in the over-extended position. This might suffice to arrest the bleeding. If it does not, and the bleeding is seen to be from one of the lateral incisions, a long strip of gauze dipped in a solution of adrenalin should be gently stuffed through the gap, and to the back of the velum, and the soft palate should be gently thrust up against this packing by means of a dry pad of gauze on a holder. Chloroform may be again required.

Sometimes, in spite of every precaution, septic inflammation attacks the mouth. The child then looks ill and yellowish, his temperature goes up, and his breath becomes foul. But with all this against it the

operation need not prove a failure. Some part of the cleft generally remains closed, and granulation-tissue in due course fills up more of it; and as soon as healthy granulations cover the surfaces (which will be in about a fortnight) the child will probably have undergone auto-immunization, and the operation may have some final touches given to it with a good prospect of a complete success being obtained. A perforation remaining after a not entirely successful operation may of itself close with time; at any rate, it will become much smaller. A hole as large as a pea may, perhaps, be seen at the junction of the hard and soft palate after the performance of an otherwise successful operation. If so, after some months, the introduction of the slender blade of a thermo-cautery will be likely to complete its obliteration.

Results. As already insisted on, the narrower the cleft and the earlier the date at which it is closed the more perfect will be the speech; the closure of a wide cleft in late childhood brings but slight improvement to the voice. Subsequent improvement depends to a large extent upon the attention which the parents devote to teaching the child to pronounce distinctly. The child should be shown the movement of the lips and tongue of the teacher when the difficult words are being pronounced, and he should be made to imitate them over and over again. A person accustomed to teaching deaf-mutes would give very helpful instruction.

If, after the performance of the pressure operation, the maxillary arch did not widen out sufficiently, this could be easily made right by a practical dentist. But even if it remained small, that defect would be more than counterbalanced by the fact that, owing to the approximation of the hinder ends of the maxillary processes, the surgeon had been enabled to form a soft palate without tension, and without interfering with the tensor and levator palati. One constantly found, after operating by the old method, that the velum was extremely tight and ill-adapted for the purpose of vocalization; but, of course, it was not left in that condition. It was relieved of tension by the method of Fergusson or Pollock, or in some other way. My own plan is to make a free incision from before backwards, with a very slender scalpel, through the velum near its lateral attachment, in fact by extending still further backwards the incision indicated by the dotted line in Fig. 75.

SECTION II

OPERATIONS UPON THE LIPS FACE AND JAWS

PART II

OPERATIONS FOR CANCER OF THE LIPS AND FACE

BY

G. LENTHAL CHEATLE, C.B., F.R.C.S. (Eng.)
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CHAPTER IV

OPERATIONS FOR CANCER OF THE LIPS AND FACE

GENERAL CONSIDERATIONS

In planning incisions for the excision of cancer from the front of the face there are four things to be considered :—

1. The writer has shown that a cancer originating in any part of the lips, angle of the mouth, or skin over the cartilaginous part of the nose, will always spread directly into the nasal and labial regions before it progresses in any other directions.

2. Wherever squamous epithelioma or rodent ulcer exists the growth has spread under the normal epithelium which surrounds the malignant ulcer ; therefore the area of disease is greater than the size of the ulcer.

3. The cutaneous striated muscles of the face are in close anatomical relation to the dermic glandular structures and almost touch the basal layer of the epidermis. The relationship of these muscles to the skin is closest round the eyelids and mucous membrane of the lips. Not only will cancer invade these muscles in its earliest stages, but the writer has seen one particular muscle, the levator labii superioris alæque nasi (caput angulare), picked out as its only path of spread.

4. There are lymphatic glands on the face, in the submental, submaxillary, and anterior triangle regions, which must be removed ; and where possible it is wise to remove *en bloc* the tissue which connects the lymphatic glands with the primary growth. To this necessity particular attention has been paid in describing the following operations.

In most cases of squamous epithelioma in the region of the lips, it is generally late in the disease that the lymphatic glands contain cancer-cells. The lymphatic glands may become enlarged quite early, but then their enlargement is generally due to a great proliferation of their endothelial cells, masses of which can be seen arranged among, and isolating patches of, the normal lymphoid tissue of the glands. Therefore, although glands may be enlarged in lip cancer, they are not necessarily cancer-bearing.

With regard to the groups of lymphatic glands on the face there is no doubt that their presence is exceedingly variable. In the cases from which the writer excised cancer in the angle of the mouth, and removed with it the specified site of the buccinator group of lymphatic glands,

he could not find any trace of a lymphatic gland during a most careful dissection of the excised parts. In one case a microscopical examination was made of the whole parts removed; it revealed total absence of lymphatic glands in this region.

The question will have to be considered whether it is advisable to remove the glands at the time the main lesion is excised. The benefit gained by removing the growth and its attached lymphatic glands at one operation is that it is possible to excise the diseased skin with its lymphatic vessels and glands *en bloc*, and hence to occasion less risk of cell-transplantation. The disadvantages are that the tissues, in which lie the lymphatic glands, are opened during the course of a septic operation.

The writer has come to the conclusion that if great care in the details of antiseptic work be observed and good drainage be subsequently provided, no great harm can occur should both stages be done at the same operation. This statement also applies to that state of affairs when the growth and the glands cannot be removed *en bloc*.

However, should it be decided to do one part first, it would be better to remove the glands first, and, later, to attack the main disease, because the glandular parts of the operation heal by first intention and no valuable time would be lost before removing the primary focus. On the other hand, should the primary focus be removed first, the period of healing would be longer in certain cases because it would remain septic for a longer period, which would delay the completion of the work.

The operations for cancer of the lips will be described first.

Preliminary measures. To avoid repetition of precautions common to all cases it is necessary to state that (1) the mouth must be cleaned with a carbolic mouth wash, 1–60 carbolic acid lotion, or some antiseptic solution daily for a week before operation. All decayed teeth must be stopped and stumps extracted. This is easily done in cases of small cancer, but in advanced cases in which the teeth cannot be cleaned nor the mouth opened, except by inducing exquisite pain, no great antiseptic preparation can be made until the anæsthetic has been administered and the diseased parts removed; then it is quite worth while to interrupt the operation to scrape and clean the teeth and to extract stumps. Before proceeding with the removal of lymphatic glands and formation of skin flaps, care should be taken to remove all soiled instruments, towels, sponges, and gloves which have been used in this part of the preparation, and to protect raw surfaces from septic contamination.

(2) When practicable, before beginning the operation, the writer advises that the ulcerated part of the cancer should be cauterized by a suitable cautery at a dull red heat until the surface of the ulcer becomes of a leathery consistence and all hæmorrhage stops. This is a precaution

taken against the possibility of transplanting malignant cells of the tumour upon the fresh cut surfaces of the normal parts. The danger of transplantation is further diminished by treating the parts to be removed with the utmost gentleness, so that cancer-cells are not squeezed from their positions on to other parts, and care should be taken that the ulcer does not touch the cut surfaces of the normal tissues during the manipulations which are necessary for its removal. Each operation will be described as far as possible in three stages: (1) the removal of the growth; (2) the removal of the lymphatic vessels and glands; (3) the plastic stage.

OPERATIONS UPON THE LOWER LIP

Cancer usually spreads along the margin of the lip, but more rarely it spreads downwards to a greater degree than usual before it eventually curls round the angle of the mouth to reach the upper lip. The importance of this observation is that in early cases it is impossible to say in which of the two directions the cancer is mainly spreading. Hence it is advisable that the incisions should be so planned as to include both paths of spread.

First stage. If a small cancer be situated midway between the angle of the mouth and the centre of the lip (see Fig. 77), two incisions should be made, one external to it and the other internal. The incisions should begin at least three-quarters of an inch away from the edge of the ulcer. The external incision is carried downwards and slightly outwards through all the structures of the lip down to bone, and ends at the lower margin of the inferior maxilla. The internal incision is carried downwards and slightly inwards through all the structures down to bone, and ends at the lower margin of the inferior maxilla. The ends of these two incisions are united by two converging incisions which meet at a point midway between the lower margin of the inferior maxilla and the hyoid bone, and are only skin deep (see Fig. 77). The mucous membrane and muscles included in the lip incisions are cut away from the jaw as close as possible to the bone.

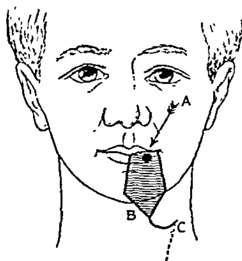


FIG. 77. INCISIONS FOR THE REMOVAL OF A SMALL CANCER, A, MIDWAY BETWEEN THE ANGLE OF THE MOUTH AND THE CENTRE OF THE LOWER LIP.

The cancer-containing tissue is not cut away from its fascia and platysma attachments, which will be taken away *en bloc* with the lym-

phatic glands. But before passing on to the next stage it is completely enveloped in a thick layer of cyanide gauze which has been wrung out of a 1–20 solution of carbolic acid.

Second stage. The lymphatic glands are then dealt with by undercutting the internal flap as far as the submental glands on each side so that all the glands in this region can be removed. The submaxillary and anterior triangle regions are exposed by means of a curved incision with its convexity downwards, and which starts at B (see Fig. 77), that is to say, from the point at which the converging incisions meet, and ends at the anterior border of the sterno-mastoid muscle, C (see Fig. 77). The flap is held upwards and backwards and the submaxillary lymphatic glands are removed, a process which is rendered easier by the removal of the submaxillary salivary gland with the facial artery and vein. If sufficient room has not been obtained for the efficient removal of lymphatic glands in the anterior triangle, an incision is made which extends downwards as far as necessary from the point C (see Fig. 77).

Third stage. In order to join the lip without tension on the stitches, the internal and external flaps must be freely divided from their attachments to the lower jaw. The parts are then stitched together and two drainage tubes are inserted, one at B and the other at C (see Fig. 77).

When a small squamous epithelioma is growing on the middle of the lower lip, the incisions are lateral and must begin at least three-quarters of an inch away from the edge of the ulcer. They are carried through all structures downwards and slightly outwards to the inferior margin of the lower jaw, and are ended in the same way as those just described in the first operation, and instead of removing the lymphatic glands from one side only, this is done on both sides by means of incisions similarly planned.

Results. The resulting deformity is not so great as would be imagined from so extensive a removal of tissue; in any case the importance of removing cancer is greater than that of leaving a picturesque appearance.

It will be observed that the V-shaped incisions, which are up to the present usually adopted for the removal of cancer from the lower lip, are not advised in this article, because they converge towards the cancer and cut across the possibly cancer-bearing tract which leads from the cancer to the lymphatic glands. The writer considers that the so-called recurrence of cancer in the lip is due to the dangerous positions of these V-shaped incisions.

That the writer is justified in attempting to expel the V-shaped incisions from surgery in connexion with cancer in this region can be seen in the figures published by Mr. C. W. Rowntree which he collected from the records of the Middlesex Hospital. Mr. Rowntree noted 126 cases of cancer of the lower lip. In the majority of instances the growth

had been removed by means of the simple V-shaped incision. There were seventy cases of recurrence, in forty of which the growth had recurred in the lip.

OPERATIONS UPON THE ANGLE OF THE MOUTH

First stage. To remove a small cancer from this part the first incision is made internal to the tumour and through the lower lip; it begins at least three-quarters of an inch from the edge of the ulcer and is continued downwards and slightly inwards as far as the lower margin of the inferior maxilla, and must cut through all structures down to bone (see Fig. 78). From this point the incision is carried through skin only, horizontally backwards along the lower margin of the inferior maxilla until it nearly reaches the anterior edge of the masseter muscle.

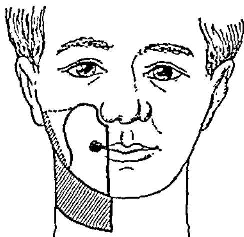


FIG. 78. INCISIONS FOR THE REMOVAL OF A CANCER AT THE ANGLE OF THE MOUTH.

The incision in the upper lip begins at least three-quarters of an inch from the ulcer's edge and is carried vertically upwards through all structures as far as the nose, around the ala of which it curves (see Fig. 78). It is not necessary to remove any part of the ala. It is then carried in a semicircle, the convexity of which is upwards, through all the structures of the cheek down to the bone, and at least three-quarters of an inch from the periphery of the ulcer until it reaches the anterior border of the masseter muscle.

The terminations of these two incisions are then joined by a curved incision, the convexity of which is directed backwards (see Fig. 78). The attachments of the parts enclosed within these incisions are then divided, care being taken not to cut through the parts left adherent to the structures below the jaw, so that they may be removed with the lymphatic vessels and glands when they are taken away.

Before proceeding with the next stage, the disease-containing flap (which has been detached everywhere except at its lower margin) must be wrapped in thick layers of cyanide gauze wrung out of 1–20 solution of carbolic acid.

Second stage. The next step is to remove the lymphatic glands *en bloc* and at the same time to keep in view the formation of a flap to cover the gap that has been created. The submental, submaxillary, and anterior

triangle lymphatic glands are easily exposed as follows: Continue the vertical incision in the lower lip downwards to the level of the hyoid bone, and carry it back to the middle of the sterno-mastoid. Turn back the flap thus marked out, and keep it protected in cyanide gauze. The region which contains the submaxillary and anterior triangle lymphatic glands is thus exposed, but to remove the submental glands of both sides the skin covering the chin and upper parts of the neck must be undercut past the middle line and held there by a retractor. It will be seen that these incisions will include the supramaxillary and buccinator groups of lymphatic glands on the face.

Third stage. The final stage is to cover the gap left by the removal of so much of the cheek tissues.

This is easily performed by sewing the flap (marked by the shaded area in Fig. 78) up to the cheek, the mucous membrane and the skin of the normal lower lip. The raw surface of the upper lip is sewn to the side of the cheek near the ala of the nose. In order to prevent puckering, and to make the flap lie nicely in its new position, it will be necessary to excise the V-shaped piece of skin from the cheek, which is marked by dots in Fig. 78, before attempting to place the flap in its final position. The flap must be well attached to the cheek and lip of the opposite side by many closely-placed interrupted stitches. The writer has never seen a salivary fistula result from this operation.

It is hardly necessary to point out that the transplantation of the flap leaves a raw surface on the neck below it. If the skin of the neck be undercut it can be brought up and stitched to the inferior margin of the flap without fear of undue tension.

Two tubes should be inserted, one at the lowest part of the wound in the middle line. and one at the posterior and inferior angle of the wound.

OPERATIONS UPON THE UPPER LIP

There are four anatomical conditions which complicate the spread of cancer in this region, and which do not concern cancers in the lower lip or angle of the mouth.

1. The early spread along the alveolar margin of the upper jaw, particularly when the disease begins in, or spreads into, the central part of the lip. The upper lip at this part is naturally shorter than elsewhere, and the lip is made smaller by the contracting newly-formed connective tissue which encircles and pervades cancer. Atrophy of the normal tissue will also accentuate the diminution in the natural size of the lip.

2. The relation of the disease to the alæ nasi and columella. When cancer begins in the upper lip, the columella is more invaded than the

alæ nasi. The septal origin of the orbicularis oris forms an easy pathway by which the disease reaches the columella.

3. The extensive area and importance of the tissues that intervene between the lymphatic glands in the parotid and submaxillary regions render it necessary to run the risk of not removing the area and glands *en bloc*, as has been advised in the two operations just described.

4. Until more trustworthy evidence is available the writer advises that the parotid glands should be left out of the question in removing small cancers from the upper lip, that is to say, unless these glands are enlarged; then of course it would be wise to remove them.

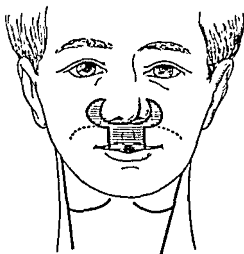


Fig. 79. Incisions for the Removal of a Cancer in the Centre of the Upper Lip. The thick lines in the neck show the incisions for removal of the glands.

The necessary steps to remove a small cancer in the centre of the upper lip are as follows: First make two lateral incisions, which must include all the structures of the lip and which start at least three-quarters of an inch away from the edge of the ulcer and are carried vertically upwards from these points to the level of the ala nasi of each side. The ends of these two incisions are then continued into the cheek, by curving them outwards; these outwardly curved incisions are to terminate at the groove which marks the junction of the ala with the side of the nose (see Fig. 79), and all the structures must be included. The two incisions are then joined by a cut, which becomes transverse after curving round the grooves formed by the junction of the cheek with the ala nasi of each side In the transverse part of this incision, the base of the columella should be also removed and the septal origin of the orbicularis oris must be detached. By adopting these measures the shaded part of the diagram (see Fig. 79) will be removed; the levator labii superioris alæque nasi (caput angulare) does not come into important relation with a small cancer of this part of the lip. A new upper lip can be formed as follows: Make on each side an incision an inch and a half long which starts from the lateral incision at a point where the upward direction of it ceases and the curved portion begins (see dotted lines in Fig. 79), and carry it downwards and outwards through all the structures, and end when it reaches the centre of the buccinator muscle. This incision must not involve Stenson's duct, the orifice of which can be seen in the mouth and easily avoided. These lateral incisions, besides forming half a new lip, will also

enable the surgeon to look for, and remove, if present, the buccinator group of lymphatic glands. The free ends of the new lip thus formed can be sutured across the middle line, and finally the cheeks can be sutured to the alæ nasi. These steps are rendered easy by thoroughly and extensively undercutting the attachments of the cheeks to bone. It will be necessary to remove the submaxillary and the supramaxillary lymphatic glands of both sides; this can be done by making suitable incisions in the submaxillary and anterior triangle regions on both sides (see Fig. 79).

The necessary steps to excise a small cancer growing in the centre of one side of the upper lip are as follows (see Fig. 80):—

An internal incision, which begins at least three-quarters of an inch from the edge of the ulcer, is made vertically upwards, as far as the columella or nostrils as the case may be, through all structures down to the bone. An external incision is carried through all structures down to the bone obliquely upwards and outwards from a point at least three-quarters of an inch from the edge of the ulcer towards the external canthus of the eye, but ends when it reaches the level of the groove which marks the junction of the ala with the side of the nose. This incision is made obliquely outwards to include the zygomaticus minor muscle (caput zygomaticum). The third incision joins the two previous ones by passing transversely inwards through all structures down to the bone, and extends from the end of the second incision to the junction of the ala with the side of the nose. This must be made to include the attachments to bone of the levator labii superioris (caput infraorbitale), the levator anguli oris (caninus), and the zygomaticus minor (caput zygomaticum) muscles; it cuts across the continuity of the fibres of the levator labii superioris alæque nasi (caput angulare). It will also include the lymphatic gland which may be found in the naso-genial groove. The incision is then continued downwards in the groove formed by the junction of the ala with the cheek, and ends by cutting across the junction of the upper lip with the nose, so as to include half the base of the columella and the septal origin of the orbicularis oris. The incisions include the shaded portion in Fig. 80. The remaining half of the lip must be the great source of supply for the tissues which are to cover the gap thus made; all its attachments to bone and to the base of the nose must be divided, and, to render it more adaptable, an elliptical piece of skin must be removed from around the ala of the normal side (see Fig. 80). These proceedings will enable the remaining half of the lip to be drawn across the gap, without interfering with the appearance of the nose. The upper lip can be formed, and the buccinator glands can be sought for, and (if present) removed, by making an incision, which includes all the structures of the cheek and which starts from the external incision at the level of the junction of the ala

with the lip, and ends, after running in a downward and outward direction, over the centre of the buccinator muscle (see Fig. 80). This flap is then stitched to the opposite lip and, in order to prevent undue puckering at the angle of the mouth, it may be necessary to make an incision into the cheek which is directed downwards and outwards from the angle of the mouth, parallel with the last incision (see Fig. 80). In order to cover the interval between the nose and the cheek, a third incision, parallel with the two just described, must be directed backwards in the cheek from the top angle of the gap (see Fig. 80); the tissues of the cheek thus separated must then be brought inwards and stitched to the ala. These steps can be performed without undue tension by extensively undercutting the attachments of the cheek to the bone.

The lymphatic glands which can always be found are the submaxillary glands, into which lymphatics from the upper lip drain, but before reaching them the lymph-stream from the upper lip may pass through the buccinator and the supramaxillary groups.

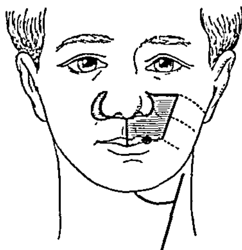


Fig. 80. Incisions for the Removal of a Small Cancer in the Centre of one Side of the Upper Lip.

The buccinator group has been dealt with in describing the necessary steps in the formation of the new lip (see p. 163). The submaxillary group is reached through an incision made below the inferior border of the lower jaw from below the symphysis to the anterior border of the sterno-mastoid. The supramaxillary glands can be reached by dissecting up the upper edge of this incision, and exposing them on the horizontal ramus of the jaw in front of the attachment of the masseter. In cancers on one side of the upper lip the supramaxillary and submaxillary glands of the same side must be removed. If the glands of the normal side be enlarged they also must be excised.

In removing large cancers from the lips a combination and modification of these incisions and flaps can be easily planned. For instance, when a cancer occupies the whole of the lower lip and the angles of the mouth, it means that the operation which has been described for the removal of cancer at the angle of the mouth is necessary, only it must be done on both sides, and one broad flap must be raised from the neck to take the place of the cancerous lower lip. This flap requires more support

than is given it by the stitches which connect it with the sides of the cheeks, and the writer has successfully kept this large flap *in situ* by four tin-tacks hammered into the lower jaw. The operations upon large cancers of the lower lip and angle of the mouth which do not involve the inferior maxilla are more favourable from the point of view of cure than are those which occupy the upper lip, as the latter soon involve the nose and superior maxilla extensively; in the case of the lower lip the disease remains so localized that even when the lower jaw is affected its removal undisturbed within the areas of incision has resulted in cure in two of the writer's cases, that is to say, if six years and ten years respectively can be justly accounted cures.

OPERATIONS UPON THE FACE

Cancers at the inner or outer canthus of the eye must be removed on the lines described for excision of cancer at the angle of the mouth; in fact the distribution of cancer of the lower lid and angles of the eyelids very much resembles the spread of cancer in the lips. For instance, a cancer beginning in the lower lid near the free margin, or at the internal or external canthus, will occupy the area around the eyes and will include the upper lid before spreading to other parts; for this reason the writer advises diverging lines as in the mouth operations, if the edge of the lid must be removed. When the cancer occurs elsewhere on the eyelids it is essential to keep the incisions at least three-quarters of an inch away from the periphery of the growth, and to perform plastic operations according to the circumstances of each case.

When cancer appears in the forehead or sides of the face it is a wise plan to first excise the disease widely, that is to say, never to allow an incision to approach nearer the disease than a point three-quarters of an inch from its edge. All the incisions should go down to bone and all the soft structures must be removed. After the cancer has been taken away it is time to settle the best plan for covering the raw surface thus made.

The operator can get a good idea from where he can form his flap or in which direction he can sew up the wound, by picking up the skin, of the normal side, in various directions, and by so doing he can estimate where there is most available skin for his purpose, on the diseased side. (See Plastic Operations, Vol. I.)

With regard to the lymphatic glands which ought to be removed when cancer occurs in the regions of the forehead and eyelids, it may be stated that the lymphatic glands in the parotid region are the most usually affected. According to Sappey and Küttner the lymphatic vessels of the skin near the inner canthus of the eye drain directly into the submaxillary region.

SECTION II

OPERATIONS UPON THE LIPS FACE AND JAWS

PART III

OPERATIONS UPON THE JAWS

BY

C. H. FAGGE, M.S. (Lond.), F.R.C.S. (Eng.)
Assistant Surgeon to Guy's Hospital

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CHAPTER V

OPERATIONS UPON THE UPPER JAW

COMPLETE REMOVAL OF THE UPPER JAW

Indications. **(i) Malignant new growths of the maxilla.** This operation is most commonly required when the bone is involved by a malignant growth, either primarily or secondarily; that is, one which in the former case arises from the periosteum, whereas in the latter it begins usually in the superjacent mucous membrane. These growths may be:

Sarcoma. Periosteal sarcoma of the maxilla is usually of the round or spindle-celled type and of rapid growth.

Carcinoma. The upper jaw may be involved by a squamous-celled carcinoma originating in the mucous membrane covering the hard palate or by a similar growth commencing in the gum, though here it is less frequently met with than in the lower jaw.

Another variety of epithelial malignant tumour involving the maxilla is a columnar-celled carcinoma, arising probably from the glands of the antral mucous membrane (Bolam, *Newcastle-upon-Tyne Journal of Path. and Bact.*, 1898, v, p. 65): owing to its destructive nature it has been called boring epithelioma (*épithélioma térébrant* of Réclus).

(ii) Cancer of the naso-pharynx Excision of the upper jaw may be required for the removal of malignant tumours of the naso-pharynx. (See also Osteoplastic resection of the upper jaw, p. 16.)

(iii) Odontomes and necrosis of the maxilla. Complete removal of the upper jaw for either of these conditions is rarely called for.

Though no attempt has been made in this article to detail the points, consideration of which determines the presence of a malignant growth in the upper jaw, it cannot be superfluous to insist that even in the hands of the most experienced surgeon considerable difficulty may be met with in definitely diagnosing the presence of a malignant growth and in excluding the possibility that the antrum is distended with pus and granulation tissue.

In all cases where the slightest doubt exists as to the nature of the lesion, before an operation for removal of the maxilla is commenced an exploratory puncture should be made through the canine fossa into

considerable deformity, which further plastic operations will probably only remedy incompletely. Consideration of each individual case will alone determine whether, under these circumstances, operation is justifiable, and before negativing operation the surgeon must make certain that the soft tissues are actually involved and not merely thinned and stretched over the growth while still movable upon it.

Secondary deposits in the submaxillary or cervical glands, resulting in so much enlargement that these are recognizable on digital examination before operation, may generally be taken as contra-indicating operation.

The cases which are most suitable for operation are those of some months' duration, arising either in the antrum or involving only one surface of the bone, and which, as far as physical examination can determine, have not extended into the adjacent cavities.

Besides the immediate and remote risks dealt with below, which are inseparable from such an operation usually undertaken in a patient beyond middle life, complete removal of the upper jaw possesses several disadvantages.

Of these the chief is the tendency of the eyeball to drop after losing the support of the orbital plate of the maxilla. This may be so marked that the affected eye may look downwards, and may not only become useless to the patient, but may cause considerable annoyance owing to the diplopia which results. When it is clear that the growth does not involve the orbital plate, this may be left, the operation being modified in the manner detailed below (see p. 179). When, however, removal of the orbital plate is essential in order to avoid the risk of recurrence, which is the chief consideration in all these operations, the ingenious plastic operation of König (see p. 178) may be employed. At the same time it is true that, provided the internal and external tarsal ligaments—by which the suspensory ligament of Lockwood is supported—are not interfered with by too free removal of the nasal and malar processes respectively, sinking down of the eyeball is unlikely to be a serious complication.

A second disadvantage is that by removal of the hard palate the mouth is left in free communication with the nasal cavity. This may be overcome in a small proportion of cases by leaving the palatal process of the upper jaw when this is clearly not involved by the growth. In a greater number of cases, even when it is deemed advisable to remove the bone in this situation, the muco-periosteum covering the hard palate may be peeled off, so that the above-mentioned disadvantage is eliminated.

While cases undoubtedly occur for which these modifications of the complete operation may be adopted, it is essential that the first consideration in the operator's mind must always be as free a removal of the

the antrum with a trocar, and should this not supply sufficient information to determine the point, the opening should be enlarged with a gouge. When the material evacuated cannot be definitely stated to be either inflammatory tissue or growth, it must be subjected to a microscopical examination before the patient is exposed to the risk of a possibly unnecessary removal of the maxilla. Cases scattered through surgical literature impress upon us the importance of this preliminary investigation, and show that mistakes have been made by surgeons of repute even where the diagnosis has been apparently of no difficulty.

The selection of cases favourable for operation. Before undertaking so severe an operation it is necessary not only to inquire into the history, but also to determine, by the presence or absence of proptosis and by the freedom or limitation of movement of the eyeball, whether the orbital plate has become involved or not; to examine the palatal surface of the maxilla, and by anterior and posterior rhinoscopy (or if the latter be impossible, by examination of the post-nasal space with the finger) to determine as far as possible whether the growth has extended beyond the limits of the maxilla. Palpation of the hollows above and below the zygoma will detect or exclude gross involvement of the zygomatic and temporal fossæ, but it is well to remember that when exposed in the course of an operation, such growths are often found to extend further upwards or backwards than had been previously suspected.

Malignant tumours, commencing at the back of the jaw or in the spheno-maxillary or pterygo-maxillary fossa, and secondarily affecting the maxilla, usually give rise to protrusion of the eyeball at an early stage and are clearly unsuitable for surgical interference. Again, tumours of rapid growth intensify the gravity of the prognosis, and as the malignant infiltration in these cases readily extends upwards into the ethmoidal cells, the walls of which are so thin as to offer but feeble resistance to its extension, displacement outwards of the eyeball or swelling in the region of the inner canthus, both suggestive of this complication, must be regarded as of grave significance. However, it is well to bear in mind, as Cheyne and Burghard (*Manual of Surgical Treatment*, Part V, p. 215) point out, that, provided the tumour is of slow growth, the fact that the eyeball is thus displaced does not render the case inoperable, because the growth may fill up the ethmoidal cells without involving the bones, and can therefore be eradicated without grave risk of recurrence.

Similar considerations apply to cases in which a mass of growth is found on posterior rhinoscopy to fungate into the naso-pharynx.

Involvement of the skin of the face, while not in itself an absolute contra-indication to operation, necessitates free removal of the soft parts over the jaw if recurrence is to be avoided, and so usually results in

preliminary is more than repaid by relieving the assistants of much sponging, and by saving time in securing vessels; further, it enables the operator to see exactly what he is doing at every stage of the operation, so that he incurs less risk of leaving fragments of growth behind.

It is usually desirable to remove the glands, both at the angle of the jaw and those deeply situated in front of the sterno-mastoid on the same side. For this Kocher advises a curved incision running from the apex of the mastoid process downwards behind and below the angle



FIG. 81. INCISION FOR EXPOSING THE CONTENTS OF THE SUBMAXILLARY AND UPPER CERVICAL TRIANGLES.

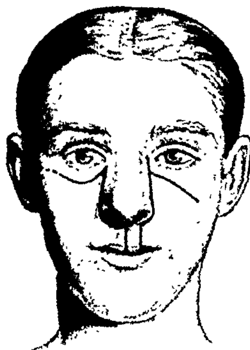


FIG. 82. INCISIONS FOR REMOVAL OF THE UPPER JAW. Right side, Fergusson's; left side, Kocher's incision.

of the jaw to the middle of the hyoid bone (see Fig. 81). He points out that in the course of removal of the submaxillary and deep cervical set of glands there is an excellent opportunity for ligature of the external carotid This is carried out before the operation of laryngotomy, which necessitates some risk of infection of the hands and instruments.

For the removal of the upper jaw itself the classical incision of Fergusson is most suitable in the majority of cases (see Fig. 82).

In carrying this out the upper lip is divided in the middle line as far as the columella nasi. The incision is then carried downwards below the nostril, and passing in the sulcus between the ala of the nose and the

malignant tumour as possible, which must never be departed from one iota for mere cosmetic considerations.

Operation. As before any other operation within the mouth all carious teeth must be removed and an antiseptic mouth-wash, such as hydrogen peroxide or chinosol (1 in 500), must be employed for several days in order to diminish the risk of oral sepsis as far as possible.

The patient is either placed in the supine position, with the head, unsupported by pillows, turned towards the affected side, or advantage will be gained by the adoption of the Trendelenburg position. Opinions are widely divided as to the advisability of performing a preliminary laryngotomy. Jacobson (*Operations of Surgery*, fifth edition, p. 483), who is in favour of this, points out that it is a much less severe operation than tracheotomy, and considers that the success of laryngotomy is due to its being performed through a fixed part of the air-passages and to the fact that the tube is removed as soon as the operation is finished. The writer's experience confirms the value of preliminary laryngotomy in eliminating the risk of inhalation pneumonia. Further, as the anæsthetic throughout the operation can be given from a Junker's apparatus through a rubber tube introduced into the laryngotomy tube, this procedure gives considerable freedom to the operator, who can carry out the operation without any fear of interfering with the anæsthetist. When preliminary laryngotomy is employed a large sponge is introduced into the pharynx, so as to block the upper laryngeal orifice completely, and this in itself considerably lessens the danger of pulmonary complications resulting from the inhalation of blood during the operation. When laryngotomy is not employed, these risks may be partially, but not so completely, overcome by plugging the naso-pharynx with a sponge. This, if large enough and firmly packed in position, will not tend to be dislodged, so as to cause any danger by being drawn into the air-passages. Some operators, however, advise that the sponge introduced into the naso-pharynx should be fastened to a long piece of silk or wire, the other end of which is secured externally.

Kocher (*Operative Surgery*, English translation, p. 102) recommends a preliminary ligature of the external carotid, pointing out that the high mortality, even in the present day, of excision of the upper jaw is largely due to hæmorrhage in patients whose vitality is insufficient, or to aspiration pneumonia, and that both of these dangers are diminished by this preliminary procedure. Jacobson (*loc supra cit.*) quotes Dr. J. D. Bryant of New York as being in favour of it, especially in patients exhausted by hæmorrhage and cachexia, and himself recommends that it should be a routine part of the operation. The time taken up by this

palate is divided in the middle line from before backwards by an incision dividing the muco-periosteum of the gum over the alveolus, and extending backwards down to the bone to the posterior margin of the hard palate. From this point it is continued transversely outwards to the tuberosity of the upper jaw. When the soft palate has been detached with a rugine, the hard palate is sawn through along a line corresponding to the division of the mucous membrane in an antero-posterior direction with a saw introduced through the nose (see Fig. 83, C). Where it is possible to leave the muco-periosteum of the hard palate the division of the palatal surface may be more easily carried out with a Gigli's saw or bone-forceps. Free separation of the cut surfaces along all the bone incisions may now be completed with forceps, and when the bone has been sufficiently loosened it may be freed with lion forceps and forcibly withdrawn, bone-forceps inserted at the inner and outer limits of the jaw being used as a lever to assist this process. If the upper jaw be still held at any point it will probably be owing to its attachment behind to the pterygoid process: this may be severed by passing the bone-forceps transversely inwards from behind the tuberosity of the jaw. As the maxilla is removed, all connecting soft parts, especially the superior maxillary nerve, are cleanly divided with scissors.

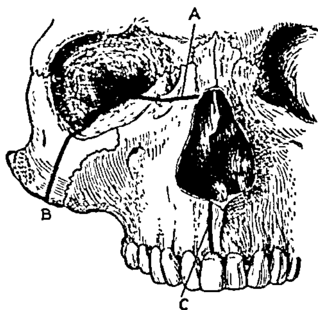


FIG. 83. LINES OF BONE SECTION IN REMOVAL OF THE UPPER JAW.

It is not unusual, when the bone has been considerably softened by infiltration with new growth, to find that it can only be extracted piecemeal, and when this is done, careful inspection, aided if necessary by artificial light, will alone ensure that all doubtful tissues are freely cut away.

At this stage of the operation free hæmorrhage is frequently met with, and this is temporarily controlled by packing the cavity with a large sterilized sponge, by which means capillary hæmorrhage is arrested. When this is withdrawn all the bleeding vessels are secured with Spencer Wells's forceps and ligatured with catgut.

cheek is carried upwards to a point just below the inner canthus, so as to avoid opening the lachrymal sac. It is then continued outwards along the infra-orbital ridge to a point below the outer canthus. This incision is carried down to the bone throughout its extent, and the flap formed by raising the soft parts from the surface of the maxilla is turned outwards. While this is being done free hæmorrhage from the superior coronary (labial), lateral nasal, and angular branches of the facial will ensue unless preliminary ligature of the external carotid has been undertaken. This hæmorrhage may be controlled by digital compression of the facial trunk as it crosses the lower jaw, and by grasping the two halves of the upper lip between the fingers as it is divided. In turning this large flap outwards care must be taken both to avoid the growth, should it have fungated through the facial aspect of the maxilla, and yet to cut the skin flap thick enough to avoid any risk of subsequent sloughing. The mucous membrane is divided horizontally along its reflection from the upper lip on to the alveolus to a point behind the last molar tooth, and the flap formed by the soft tissues is reflected backwards as far as the anterior border of the masseter.

Attention must now be paid to all bleeding points, which are secured by Spencer Wells's forceps. The orbital periosteum, when not involved, is now raised throughout the whole extent of the floor of the orbit, and in doing this the origin of the inferior oblique will be detached and carried upwards with the other orbital contents. On the inner side the incision should have passed into the nose by dividing the fibrous tissue and mucous membrane along the concave margin of the bony anterior nasal orifice. The nasal (frontal) process of the superior maxilla and the adjacent portion of the nasal bone should now be divided with bone-forceps, so placed that the cut will extend backwards towards the inferior border of the sphenoidal (superior orbital) fissure (see Fig. 83, A). The junction of the maxilla with the malar bone must now be severed, and this is best carried out by free separation of the soft parts to expose the anterior extremity of the spheno-maxillary fissure, through which a Gigli's saw may be passed from above downwards, and the bone divided from behind forwards. The line of this bone incision must necessarily vary according to the extent of the disease, but when there is no reason to fear that the growth has extended into the temporal and zygomatic fossa, it should lie only just outside the malo-maxillary suture, and should avoid the anterior fibres of origin of the masseter muscle, as when the malar prominence can be left behind less deformity will result from sinking in of the normal prominence of the cheek (see Fig. 83, B).

The mouth is now opened in order to free the palatal attachments of the upper jaw, and if necessary the central incisor is drawn. The hard

modifications of Fergusson's incision have been employed, of which the following are the most important.

Kocher recommends the adoption of *Nélaton's incision* in cases where free access to the regions of the orbit and malar bone is not required. This is similar to Fergusson's, but stops short at the inner canthus of the orbit. When, however more room is required above, Kocher carries the incision downwards and outwards at a lower level than Fergusson's incision, along the lower edge of the orbicularis palpebrarum (oculi), but above the origins of the levator labii superioris (caput infraorbitale) and zygomatic muscles. This is so placed that it falls between the upper and lower areas of the distribution of the facial nerve (see Fig. 82).

Kocher employs, for extensive growths, a modified *Dieffenbach's incision* (see Fig. 84, A), which is carried perpendicularly through the upper lip, and then upwards along the nose, just external to the middle line. The inner canthus is then divided, and the incision runs along the inferior conjunctival fornix to the outer canthus, beyond which it is continued horizontally as far as may be necessary. In such operations Kocher recommends that the eyeball should be removed, for by this means free access is obtained for the removal of growth in the region of the ethmoid, where he says recurrence is specially apt to occur after operation for tumours in advanced stages. As it is impossible to be sure before the commencement of such an operation to what limits the growth may have extended, it is always well to obtain the patient's consent to removal of the eyeball before operating. This will, however, only be called for when the soft tissues of the orbit are actually involved, or the growth has fungated to such an extent into the ethmoidal cells that free access is impossible while the eye remains in position.

Modifications of the original incision will be required when the growth has fungated, and is involving the soft parts covering the facial aspect of the maxilla. In this case the incision must be planned so as to give the invaded tissues a wide berth, the only point to be considered being that the growth shall be freely got rid of. After this a plastic operation on the face will be necessary, skin flaps being obtained from the cheek, frontal or cervical regions (see Vol. I).

König's operation. As is pointed out above, removal of the orbital plate of the maxilla may result in serious disfigurement from falling downwards of the eyeball and from associated œdema of the lower lid. König has introduced a plastic operation to prevent this deformity (Schlatter, *v. Bergmann's Surgery*, vol. 1, p. 731). He tries to prevent dislocation downwards of the eyeball and sinking down of the lower lid by supporting the eyeball with a flap taken from the temporal muscle.

When all severe bleeding has been controlled it is well to inspect the whole cavity carefully in order to ensure that no growth remains behind, and in doing this comparison of the mass just removed with the cavity remaining will direct the operator's attention to the points at which this is most likely, for if the upper jaw has been broken in removal, and a portion of the capsule of the growth is adherent at any point, it is probably there that remains of the growth have been left behind. All irregular rough fragments of bone must be carefully removed with bone-cutting forceps: such trimming of the bony cavity will probably be called for at the upper and back part of the wound, where fracture of the maxilla rather than separation of the whole bone from the palate and ethmoid is likely to take place.

When it is quite certain that the whole growth has been removed, and when all hæmorrhage has been arrested, the cavity is firmly packed with one long strip of iodoform gauze wrung out in weak carbolic lotion. Before this is done Cheyne and Burghard recommend that the raw surface should be mopped over with a solution of zinc chloride (40 grains to the ounce), and Jacobson (*loc. supra cit.*) is in favour of using a similar application, or Whitehead's varnish (containing benzoin, ethereal solution of iodoform, and turpentine), but when possible he is in favour of omitting to plug the cavity. Other surgeons soak the gauze packing with an emulsion of sulphur in glycerine.

In the writer's experience careful search for detached particles of growth, aided if necessary by an electric forehead-light, and their free removal with scissors or bone-forceps, is better than to trust to the action of any caustic applications, and in his experience the subsequent bleeding has been so slight as not to call for the use of local styptics.

The *opening between the nose and the mouth is now narrowed* as much as possible by sewing the detached half of the soft palate to the cut margin of the mucous membrane of the cheek and to the other half of the palate.

The edges of the skin wound may now be brought together with superficial catgut sutures. Jacobson advises that especial care should be paid to the insertion of these sutures at two points: one the angle of the flap near the inner canthus, where, if sloughing of the skin takes place, ectropion will follow; the other at the lower margin, where care must be taken that the red line of the upper lip is accurately sutured. Further, it is important to carefully suture the mucous aspect of the lip, in order to avoid the possibility of the lip becoming adherent to the cut edge of the alveolus, when imperfect movement will result.

***Modifications of* and additions to the above operation.** Numerous

with the soft palate: or, as advised by Cheyne and Burghard (*loc. supra cit.*), the muco-periosteum may be reflected inwards after an incision has been made on the side affected within the alveolus, extending from the mid-line in front to the hamular process behind; in either case the soft palate should be detached behind. After the jaw has been removed, the palatal flap is replaced and sutured to the cut margins of the buccal mucous membrane and to the soft palate behind with interrupted catgut sutures.

Similarly, when the lower part of the upper jaw is alone involved, and the parts have been exposed by Nélaton's incision described above, the orbital plate of the maxilla may be left intact. When this is possible it should always be done, as it obviates some of the gravest objections to removal of the upper jaw. In order to carry this out, the maxilla is divided horizontally below the infra-orbital ridge, partly with a saw, partly with a chisel and mallet,[1] the lower part of the maxilla being removed by the method previously described.

After-treatment. The patient is returned to bed, and is well propped up on a bed-rest or pillows, in order to hamper the movements of the chest as little as possible. Feeding for the first few days is to be carried out with nutrient enemata, but water *ad libitum* should be given through a drinking-cup, in order to quench thirst and to wash away unpleasant discharge. The mouth should be frequently mopped out or sprayed with sanitas, and the patient allowed to gargle with potassium permanganate or resorcin lotion. After two or three days fluids may be given by the mouth through a long indiarubber tube attached to a feeding-cup. The gauze packing is removed after twenty-four hours, and the cavity is lightly repacked. This is repeated until granulation commences.

Owing to the frequency of pulmonary complications it is well to allow the patient to sit up in bed on the third or fourth day, and to leave his bed for an arm-chair or wheeled couch within a week of the operation.

Dangers and difficulties. The chief risks of this operation are due to hæmorrhage, which is best overcome prophylactically, either by preliminary ligature of the external carotid or by compression of the arteries likely to be divided, as mentioned in the account of the operation. Bleeding is also dangerous from the possibility of blood entering the larynx, resulting in coughing and dyspnœa, and inspiration of blood-stained saliva which is likely to give rise to a dangerous or fatal broncho-pneumonia. These complications are best avoided by preliminary laryngotomy and plugging of the pharynx, though Cheyne and Burghard

[1] Or a Gigli's saw may be passed from without inwards through the pterygo-maxillary (pterygo-palatine) fissure into the nose (Schlatter), when the maxilla may be cut through at whatever level is desired.

From the insertion of the temporal muscle to the lower jaw he takes a strip of muscle of half a finger's breadth attached to a piece of the anterior border of the coronoid process of the inferior maxilla, which he chisels away as far as the horizontal ramus. He then carries this transversely inwards below the eyeball, where it is attached to the remains of the frontal process of the maxilla, so as to support the eyeball.

In order to overcome the disadvantage of the free communication between the nasal cavity and the mouth, Bardenhauer (Schlatter, *v. Bergmann's Surgery*, vol. i, p. 731) uses the nasal septum to fill up the defect in the hard palate. The septum is detached from the anterior portion of the frame of the nose and the base of the skull, and is turned outwards upon its inferior attachments until it assumes a horizontal position. It is then sutured to the soft palate behind and to the edge of the mucous membrane of the buccal flap externally.

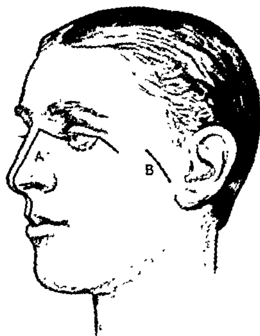


FIG. 84. INCISIONS FOR OPERATIONS UPON THE JAWS. A, Dieffenbach's incision for removal of the upper jaw; B, Incision *for operations upon the interarticular* fibro-cartilage, or for excision of the condyle of the mandible.

This deformity may be overcome when the parts are soundly healed by the fitting of an obturator carrying a denture.

It has been pointed out above (see p. 171) that, when the growth is limited to the upper part of the jaw, the palate may be left entire, or when it is considered unsafe to leave the bony palate the muco-periosteum of the roof of the mouth may be saved. The first-named modification is very rarely safe, but when possible it may be carried out, after reflection of the facial flap and free exposure of the maxilla, by sawing horizontally outwards with a fine saw introduced into the nose immediately above the level of the hard palate. This procedure will be rarely available, as it interferes considerably with later inspection of the highest and deepest part of the cavity, and it must be borne in mind that it is here that it is most difficult to deal radically with the growth. When the operator intends to save the muco-periosteal covering of the palate, this may be divided along the mid-line and raised outwards as far as or beyond the alveolus after it has been cut through transversely behind at its junction

whilst in those reported by Heyfelder, Reid, Esmarch, and Baum there were 19 deaths out of 55 operations, or 16·3%. König (1898) states that the immediate mortality is especially high after total resection for malignant growths, and puts it at about 30%. Butlin (*Operative Surgery of Malignant Disease*, p. 136) is of opinion that the mortality after removal of the upper jaw is still very high. Eve (*loc. supra cit.*) records a mortality of 16·6% in 12 operations undertaken in the last six years. Before the antiseptic period pyæmia, septicæmia, erysipelas, and meningitis were the most common causes of death, whilst during the last decades disorders of the air-passages predominate, death resulting from septic bronchitis, broncho-pneumonia, and suffocation, owing to flooding of the air-passages with blood during the operation.

The late results of these operations are even more disappointing. Schlatter (*loc. supra cit.*) records recurrence in an average of 3·9 months in all his cases where the whole maxilla was involved. Küster obtained no permanent good results; in the statistics of the Erlangen Clinic there was one permanent cure in 17 cases, in those of the Greifswald Clinic no cure in 17 cases; Estlander had 10 recurrences in 12 cases. Martens reports 72 total resections in the Göttingen Clinic, resulting in 23 deaths and 16 permanent cures, the disease recurring in all the other cases. In 13 cases of complete resection for carcinoma of the upper jaw reported by Stein in von Bergmann's Clinic (1890 to 1900) there was recurrence in every instance in an average of 3·6 months, death usually resulting in about thirteen months. In 11 cases in which total resection was performed for sarcoma death occurred in 3, recurrence in 2, whilst 6 remained well up to the time when the cases were reported. Stein reports 47 cases in which total resection was carried out in the Berlin Clinic, with 12·6% cures. In the cases of partial resection reported, permanent cure for at least three years occurred in 50%.

PARTIAL REMOVAL OF THE UPPER JAW

Indications. (i) For the removal of malignant growth not involving the whole maxilla: modifications of Fergusson's operation required in such cases have been described above.

(ii) For epulis. This is a term applied clinically to tumours arising from the gum close to the teeth and includes growths of widely varying characters. While all arise in the alveolar periosteum or in the periodontal membrane, they may be benign fibrous growths or fibro-sarcomata of slight but definite malignancy. Eve (*loc. supra cit.*) states that among 30 cases removed at the London Hospital recurrence took place in 18·2%.

state that they have not met with a case in which they have thought this necessary.

Shock. In the aged, those suffering from advanced arterial degeneration or defective nutrition due to inability to take food readily before the operation, or in those suffering from malignant cachexia, this is likely to be marked. In Eve's opinion (*Brit. Med. Journ.*, 1907, vol. i, p. 1525) the preliminary operations of laryngotomy and ligature of the external carotid tend to decrease shock and do not prolong the operation, as much time is saved in sponging and securing vessels. Rapid operation, great care in limiting the amount of hæmorrhage, and hypodermic injections of adrenalin are the most important antidotes for this condition.

Recurrent or secondary hæmorrhage may be dealt with by the application of an ice-bag to the face or by douching with cold water. The gauze packing may be soaked in a solution of adrenalin chloride (1 in 1,000). Should these fail, ligature of the external carotid may be called for if this has not been done as a preliminary measure.

Inhalation pneumonia is a considerable risk during the first few days, when the patient's power of expectorating discharges is reduced. Infection of the wound, followed by cellulitis or erysipelas, is likely to occur in feeble patients, the subjects of advanced disease, where the growth has already undergone necrosis, and must be dealt with as in other parts of the body by free incisions, and fomentations of boric or mercuric perchloride lotion, frequently applied.

Results. Krönlein (*Langen. Arch.*, 1901, vol. lxiv, p. 265) states that in 1872 Langenbeck, owing to the great diversity of opinion as to the immediate danger in this operation, expressed the wish that statistics might be collected as to the mortality, but the repeated attempts which have been made to do so by the *Deutsche Gesellschaft für Chirurgie* have not met with much success. Langenbeck considered that the risk was undoubtedly very great, especially in individuals of sixty and upwards, whilst Volkmann believed that death very rarely resulted from resection of the upper jaw. Baum puts the mortality at a little over 10%.

In 1847 Dieffenbach performed more or less extensive resections in 32 cases, none of these patients dying from the operation and its immediate results; it is not, however, stated how many were total resections. Before the antiseptic period (1844 to 1870), out of 115 total resections found in the literature there were 37 deaths, that is to say, a mortality of 32·1%, whilst during the antiseptic period (1871 to 1897) out of 158 cases there were 33 deaths, or 21 5%. Krönlein points out that this decrease of mortality is by no means general. For example, in the cases reported by Küster and Konig the mortality was 29·1%,

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Operation. Under a general anæsthetic a tooth on either side of the epulis is extracted. A vertical cut is then made upwards, lateral to the sockets of the extracted teeth, through the alveolus with an Adams's saw. The muco-periosteum of the gum is divided within the limits of that part of the alveolus isolated by the saw-cuts, and this portion of the alveolus is detached with a Gigli's saw, chisel and mallet, or bone-forceps. Bleeding is now controlled by pressure, and a small gauze dressing is packed into the gap. The mouth is frequently rinsed out with a non-irritating antiseptic lotion. The mucous membrane is allowed to re-form so as to cover the gap in the alveolus, which at the same time undergoes considerable atrophy. After a period of six months the resulting deformity may be reduced to a minimum by the provision of a well-fitting plate carrying teeth to replace those removed at the operation.

OSTEOPLASTIC RESECTION OF THE UPPER JAW

Indications. (i) For the removal of naso-pharyngeal benign growths, such as fibromata. This will rarely be called for, as they can usually be removed without danger of recurrence by a snare introduced through the nose, or by Moure's operation (see Vol. IV).

(ii) For the removal of malignant growths growing from the base of the skull and projecting into the naso-pharynx, or extending into it from the spheno-maxillary fossa or nose. Here osteoplastic resection of the jaw is only called for when it is thought that sufficient space will not be obtained by Gussenbauer's method (Schlatter, *v. Bergmann's Operative Surgery*, vol. i, p. 733). In this operation the muco-periosteal covering of the hard palate is divided in the median line, and reflected with an elevator to either side as far as the alveolar processes. The palatal processes of the maxillæ and palate bones are then resected, and the mucosa covering the floor of the nose and the lower part of the septum is removed. After extirpation of the tumour the two lateral flaps of the palatal muco-periosteum are sutured

The advantages of the above operation, which is very similar to that described by Nélaton, and to which his name is given by some, are firstly that no deformity of the face from scarring results, and secondly that it is followed by less hæmorrhage than results from Langenbeck's operation. But its great disadvantage is that, owing to the limited space available, considerable risk is run of leaving behind portions of the growth, so that recurrence is more probable than after the more extensive operation of Langenbeck.

Dr. Robin Massé collected 26 cases dealt with by Nélaton's operation,

of which 13 were successful. Walsham (*Med. Soc. Trans.*, vol. xix, 1896, p. 394) found that by this means he had succeeded on several occasions in obtaining adequate space for the removal of naso-pharyngeal growths. He advocated the operation because, though such growths may extend into the nose and even cause the eyeball to protrude, only rarely do they invade the upper jaw or turbinates, and consequently he thinks that as a rule osteoplastic resection of the jaw is unnecessary. Further, in his opinion osteoplastic resection entails the following disadvantages : some scarring of the face, interference with the lachrymal duct, and sometimes œdema of the lower eyelid, which is prone to persist. He adds that reflection of the maxilla is attended with considerable shock and often severe hæmorrhage.



Fig. 85. Incision for Langenbeck's Osteoplastic Resection of the Upper Jaw.

Operation. *Langenbeck's method.* A skin incision is made from the inner canthus of the eye along the infra-orbital ridge, extending to the middle of the zygomatic arch. from this point it curves downwards, and turns inwards to the lower border of the ala of the nose (see Fig. 85). The soft tissues are not reflected, but are turned inwards, together with the bone, at a later stage in the operation. After detaching the origin of the masseter from the lower border of the zygoma, an elevator is passed through the pterygo-maxillary (pterygo-palatine) fissure into the spheno-maxillary (ptěrygo-palatine) fossa, and guided by this an Adams's or a keyhole saw is introduced towards the naso-pharynx, where its extremity is caught by the index-finger of the left hand, which has been inserted into the naso-pharynx through the mouth. The upper jaw is now sawn through horizontally above the level of the hard palate, as far as the anterior nasal orifice, thus freeing it from below (see Fig. 86, c). It is detached externally by dividing the zygoma with a saw or bone-forceps and by freeing the malar bone from the soft parts (see Fig. 86, A). The superior attachments of the jaw are severed by dividing the frontal process of the malar bone as far as the spheno-maxillary fissure, and by cutting through the orbital plate of the maxilla with bone-forceps, carefully avoiding the lachrymal sac (see Fig. 86,

B and D). By means of an elevator inserted under the malar bone the portion of the upper jaw outlined by the saw-cuts can now be levered inwards towards the median line, in doing which the deep connexions of the maxilla with other bones will be fractured. The tumour can then be lifted from the naso-pharynx or adjacent fossæ, and its pedicle detached from the base of the skull by means of a knife, scissors, or thermo-cautery. Finally the jaw is replaced and secured in position by skin sutures.

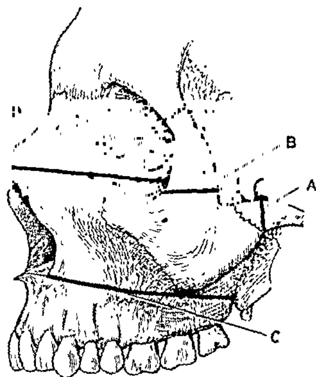


FIG. 86. LINES OF BONE SECTION IN LANGENBECK'S OSTEOPLASTIC RESECTION OF THE UPPER JAW.

Dangers and difficulties. Unless the posterior connexions of the jaw have been thinned by the naso-pharyngeal growth, and the fossæ at the back of the jaw have been enlarged from the same cause, there will be great difficulty in separating this portion of the upper jaw, which has so many articulations with the other bones of the face; and even when this has been done this method will often provide insufficient access if the growth be of large size. Undue force again is likely to crush the part of the upper jaw removed, or to break through adjacent delicate bones, so that necrosis may result. If the portion of bone to be resected be clear on one side, but remains attached and fixed at another, severe hæmorrhage, which cannot be located so as to be controlled, is likely to ensue. The risk of any blood entering the air-passages should be eliminated in the same way as was recommended in removal of the upper jaw (see p. 172), namely, by conducting the operation in the Trendelenburg position and by performing a preliminary *laryngotomy*, after which the pharynx is firmly packed with sponges. Lastly, difficulty is often met with in replacing the bone accurately, and fitting it in place.

Owing to the above serious dangers and disadvantages it is scarcely surprising that many surgeons advocate, for cases requiring more extensive operation than can be ensured by the intranasal or by Moure's

method (see Vol. IV), that the upper jaw should be partly or completely removed.

In favour of partial or complete removal of the jaw for naso-pharyngeal growths is the fact that much freer access to the roof of the naso-pharynx, from which growths usually spring, is obtained by an operation such as Fergusson's.

The operation of osteoplastic resection of the jaw entails a similar disfiguring scar upon the face, and preliminary laryngotomy is, as pointed out above, equally desirable here as it is as a preliminary to complete removal of the jaw. Cheyne and Burghard (*Manual of Surgical Treatment*, Part V, p. 230), in advocating partial removal of the jaw rather than osteoplastic resection, point out that it is unnecessary to remove the orbital plate, and that the periosteum of the hard palate can be retained. For the details of this operation the reader is referred to p. 172.

CHAPTER VI

OPERATIONS UPON THE LOWER JAW AND THE TEMPORO-MAXILLARY JOINT

OPERATIONS UPON THE TEMPORO-MAXILLARY JOINT

OPERATION FOR SUBLUXATION OF THE INTERARTICULAR FIBRO-CARTILAGE

Indications. When local medication has failed to relieve the symptoms operation may be undertaken as follows :—

Operation. An incision one inch long is made obliquely from before backwards and downwards over the joint, and is carried down to the capsule (see Fig. 84, B). In making this incision the chief structures to be avoided are branches of the facial nerve. This may be done by planning the incision so that it shall run forwards and upwards in the same direction as the temporal branches, and by taking care that any filaments exposed are carefully drawn aside. The superficial temporal artery and vein, with the auriculo-temporal nerve, lie more deeply between the condyle and the tragus, and should be in no danger of injury.

Attention must now be paid to bleeding points, and the outlying lobules of the parotid gland, which often overlap the condyle, must be turned backwards ; the masseter is defined in front of the joint, so that the latter may be freely exposed. When this has been done the capsule is opened by a vertical incision, and the fibro-cartilage is seized with forceps and dragged back into its natural position, where it is sutured by stout catgut sutures at the temporo-maxillary capsule as near as possible to its attachment to the margins of the glenoid fossa. When the interarticular fibro-cartilage cannot be replaced by this method, or when it is fenestrated or torn considerably, relief may be obtained by its complete removal.

The capsule is now re-sutured and the wound closed. Active movements are controlled as far as possible for a week, during which time the patient is fed by fluids through a tube. Annandale (*Lancet*, 1887, vol. i, p. 411) records the results of operation upon two women, aged respectively 38 and 18. The movements of the joint became natural and the jaws could be opened and closed perfectly.

OPERATION FOR AN UNREDUCED DISLOCATION

When dislocation of the lower jaw resists replacement by manipulation, even under an anæsthetic, open operation must be resorted to. The joint is exposed in exactly a similar method to that which has just been described (see p. 186), when the condyle is levered into position with an elevator.

Open operation facilitates reduction by enabling the surgeon to remove part or the whole of the interarticular fibro-cartilage, which is one of the possible obstacles to reduction by manipulation. Kocher (*Operative Surgery*, 4th edit., p. 106) states that he has reduced by open operation a dislocation of the jaw of four months' duration, and obtained an excellent result.

Should reduction, even after free division of the capsule, with or without removal of the meniscus, be impossible, excision of the condyle should be undertaken in order to restore movement.

EXCISION OF THE CONDYLE OF THE LOWER JAW

This operation, sometimes termed excision of the temporo-maxillary articulation, only deals with that portion of the articulation formed by the condyle of the mandible, and therefore the heading used above more correctly defines its nature. It is required when a patient is unable to open his mouth sufficiently to take food, or when the inability to open the mouth results in fœtor of the breath and difficulty of speech, which condition is frequently increased by the presence of septic roots. This operation will only avail when the fixation of the lower jaw is due to pre-existing disease of the temporo-maxillary joint or to an unreduced dislocation.

Bony or fibrous ankylosis may result from pyæmic arthritis, suppurative arthritis following a punctured wound, gonorrhœal and rheumatoid arthritis, or from a fracture of the condyle involving the joint. Unreduced or recurrent dislocation may also call for a similar operation, which may be required on one or both sides.

Operation. An incision is made from in front of the lower end of the tragus upwards and forwards for 1½ to 2 inches. This is carried through the skin and the deep fascia. As in the preceding operation, care must be exercised to avoid the branches of the facial nerve and the superficial temporal vessels. A vertical incision is now made, so as to open the capsule freely and to expose the neck of the lower jaw. The capsule is divided sufficiently to allow the condyle to be levered out of the glenoid fossa with an elevator, and after those fibres of the external pterygoid attached to the neck of the jaw have been freely

detached with scissors the neck of the bone is divided with bone-forceps or with a Gigli's saw (see Fig. 87, C). If diseased, the interarticular fibro-cartilage is excised, and, when the operation is undertaken for recent suppurative arthritis or for tuberculous disease, the glenoid fossa is carefully scraped with a Volkmann's spoon. The mouth should be opened to its full extent with a Mason's gag or a wooden wedge, and, if this cannot be done, it may be necessary to remove an additional piece of bone below the condyle. The wound is now sutured without drainage.

Arbuthnot Lane (*Clin. Soc. Trans.*, vol. xxix, p. 1), in recording four cases of excision of the temporo-maxillary joint for bony ankylosis in children, draws attention to the difficulty experienced in removing enough of the bone, which in cases of ankylosis developing early in life and remaining fixed for a long period is always abnormally broad and thick. He says that the part of the jaw which 'is continuous with the squamous portion of the temporal bone must be freely removed', and that its excision was in some of his cases a matter of much difficulty. He recommends that the surgeon should remove very much more bone than would at first sight seem necessary if he wishes to secure a good joint. He also is of opinion that the formation of a new articulation after such an operation is more successful in childhood than in adult life.

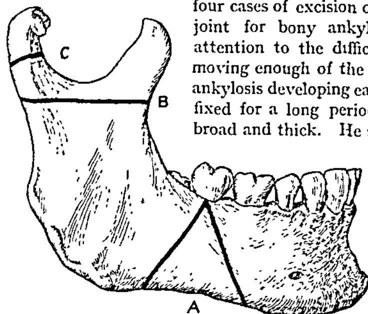


FIG. 87. OPERATIONS UPON THE LOWER JAW. Lines of bone section for: A, Esmarch's operation; B, Excision of both processes of lower jaw; C, Excision of condyle of lower jaw.

Mears (*Amer. Journ. of Med. Sci*, 1883, p. 459) quotes the case of a girl in whom excision of the condyle was undertaken for unilateral bony ankylosis of seventeen years' duration, due to a gunshot wound. This did not allow separation of the jaws, which could, however, be forced apart to the extent of one inch after the coronoid process and a bridge of new bone which had formed near it had been freely resected. Jacobson (*loc. supra cit.*) obtained a favourable result by this method in another case.

After-treatment. Care must be taken to avoid any relapse, and in order to do this, passive movements must be employed on the

second day, and forcible opening of the mouth must be frequently carried out, if necessary under a general anæsthetic.

Kocher (*loc. supra cit.*) remarks that mobility readily returns after unilateral excision, and even after a bilateral operation a satisfactory result may be ensured *if active movements are at once carried out*. To prevent the recurrence of bony ankylosis Helferich places part of the temporal muscle between the glenoid fossa and the mandible, while Kusnagow uses a slip cut from the masseter for the same purpose.

OPERATIONS UPON THE LOWER JAW

PARTIAL REMOVAL OF THE LOWER JAW

Indications. Partial removal of the mandible may be required:

(i) *For epulis.* The observations made upon epulides and the operation for their removal when arising in the upper jaw equally apply here; the operation is carried out in exactly the same way as described on p. 182.

(ii) *For the removal of an epitheliomatous growth arising in the floor of the mouth or upon the lip, and extending on to the gum.* Under these circumstances removal of a portion of the lower jaw may be necessary, as it must be borne in mind that it is impossible to remove the mucous membrane of the gum so freely as to eliminate the possibility of recurrence without detaching the nutritive periosteum from the bone, when necrosis is likely to ensue. Again, when an epitheliomatous growth arising in the gum has been stripped off the lower jaw it is not uncommon to find that the growth recurs upon the bone, so that when there is any suspicion that the periosteal surface of the gum is involved it is wiser to resect the affected portion of the jaw with the muco-periosteum covering it, in one piece and at one operation, rather than to wait until recurrence occurs which will necessitate a more extensive removal of the bone. At the same time it is well to bear in mind that at first epithelioma will only involve the alveolus, so that it may be possible to remove the affected part widely without destroying the continuity of the lower jaw. Cheyne and Burghard (*loc. supra cit.*) point out that this is of extreme importance, owing to the difficulties in mastication which are likely to ensue after resection of a portion of the whole thickness of the mandible, from alteration in the line of the teeth.

(iii) *For the removal of myeloid sarcomata of the mandible.*

(iv) *For extensive necrosis of the lower jaw*, the result of periostitis following dental caries, fracture, or phosphorus poisoning. The last-named affection is now of extreme rarity in this country, and, as it is

mainly due to tuberculous disease, it is dealt with separately by Mr. Stiles (see p. 38).

Operation. When the lower jaw is involved by the extension of an epitheliomatous growth, it is usually the body which is affected, and therefore it is this portion of the jaw which most commonly requires removal. A vertical incision is made through the lip to below the chin, from which a curved incision, convex downwards, is carried on one or both sides to the hyoid bone, then backwards and upwards to the tip of the mastoid process (see Fig. 88); the greater part of the above incision is required for the removal of the growth from the floor of the mouth and of the submaxillary and upper cervical lymphatic glands rather than for the resection of the bone, though its removal is somewhat simplified by carrying out the full incision at an early stage of the operation. The inferior coronary and other divided arteries having been secured, the soft parts are detached and reflected laterally as far as may be necessary. The level of bone sections being decided upon, one or more teeth are extracted on either side of these lines. The bone may now be divided with an Adams's saw working from the external surface; or the soft parts may be detached on the inner surface of the jaw, sufficiently to allow of the passage of a Gigli's saw, with which the bone is more easily divided from within outwards. It is easier to saw the bone three-quarters through, and then, after making the second section, to complete the first with bone-forceps, rather than to divide it completely at one spot before beginning the second cut. Care should be taken that the affected bone and soft parts are removed in one piece, and that the tongue, which must necessarily be deprived of its muscular attachments if the section involves the symphysis, does not fall back and produce serious dyspnœa.

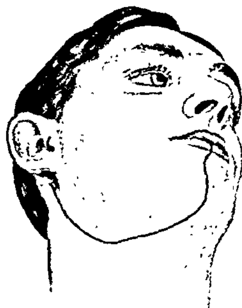


FIG. 88. INCISION FOR EXCISION OF THE LOWER JAW. (*After Kocher.*)

Removal of part or of the whole of the horizontal ramus is called for in dealing with a myeloid sarcoma, or in cases of extensive necrosis. The details of the operation have been mentioned above; in the case of removal of bone for necrosis it is usually possible to preserve the periosteum, so that new bone will be formed within it.

When, however, a complete section of the lower jaw and its periosteum has been removed, it is important to overcome the tendency which the remaining portions manifest of being drawn together towards the middle line by the unopposed external pterygoid muscles: unless this is done the lower jaw becomes contracted, and its teeth cannot be apposed to those of the upper jaw. The ideal method here is the employment of immediate prosthesis, using a perforated metal plate secured at either end to the separated parts of the mandible, so that the remaining teeth in the lower jaw are maintained in accurate alinement with those of the upper. Of the numerous mechanical appliances which have been devised on this plan, Claude Martin's apparatus (Schlatter, *v. Bergmann's Operative Surgery*, vol. i, p. 722), or one of its various modifications, is the most suitable, but as these entail the fixation of the jaw by a metal bar held in position by screws or pegs, the risk of oral sepsis and possibly of necrosis is considerable. In many cases a metal interdental splint made from plaster casts taken before operation and fitted while the patient is under the anaesthetic fulfils all requirements and can be more easily kept clean: occasionally it is better to rely upon secondary prosthesis when a metal interdental splint to bridge over the gap resulting from the operation and to restore the normal outline of the remaining teeth is fitted as soon as the wound in the floor of the mouth is covered with healthy granulations. Whatever method of prosthesis is employed, it is necessary to place the patient in the hands of a dentist for the application later on of a permanent denture to replace the teeth which have been lost. In every instance septic roots must be extracted and carious teeth stopped before such an operation is undertaken.

Schlatter (*loc. supra cit.*) speaks favourably of the use of a metal plate, which is fastened to the stump of the lower jaw on the outer side of the teeth, to which it is connected by wires: the metal plate is directed upwards and outwards, and when the mouth is open projects beyond the upper teeth. In mastication the teeth of the upper jaw impinge upon this inclined plane, and thus tend to push outward that fragment of the lower jaw to which it is attached.

In some cases the deficiency can be supplied by a plastic operation, using material from the remaining portion of the jaw, or from the femur, clavicle, or frontal bones.

Krause (*Centralb. f. Chir.*, 1904, No. xxv, p. 767) describes a method which he has adopted. Four to seventeen days after resection of the lower jaw, he fills up the defect from the neighbouring intact portions of the jaw; from these he forms a flap of skin, muscle, periosteum, and bone, 5 to 7 centimetres in length and more than a centimetre in height, which remains connected along its lower border with the neighbouring

soft tissues. This flap is inserted into the defect, and the extremities of the bone graft are fixed to the free ends of the lower jaw by two silver wire sutures, the soft parts being sutured together. The resulting defect in the neck is diminished by means of sutures, so arranged that they do not involve the flap. There is no danger of necrosis of the bony portion of the flap, and the actions of swallowing and opening the mouth are accomplished without difficulty.

Pichler and Ranzi (*Langen. Arch.*, 1907, vol. lxxxiv, p. 198), in an article on prosthesis of the lower jaw, state that Claude Martin's method of immediate prosthesis did not meet with the favourable reception which might have been anticipated, owing to the apparent danger of the entrance of septic foreign bodies into the wound, though good results have been obtained from it. Attempts have been made to replace the defect by a simple sterilizable apparatus, such as Sauer's bandages, Bönnecken's metal splint, &c. The more recent prostheses have been constructed upon Martin's original idea, namely, replacement by an intact portion of the lower jaw under strict asepsis. The apparatus employed by Stoppany-Schröder and Fritzsche consists of a massive central piece of tin, fitted with a perforated strip of metal on either side, the latter being attached by means of metal wire to the stump of the jaw. The splint is not firmly attached to the metal strips, but can be removed by taking out the pegs (or rods), rendering inspection of the wound possible. After resection of one half of the lower jaw the apparatus usually has a metal strip at one end for attachment to the intact half of the jaw, whilst the other extremity is inserted into the glenoid cavity as an artificial condyloid process. In one case, in which this method was employed after resection of the lower jaw for carcinoma involving the floor of the mouth and the lower jaw, the temporary apparatus was replaced five weeks later by a permanent one, furnished with artificial teeth. There was no recurrence six months after the operation, and the cosmetic and functional results were good.

Pichler and Ranzi state that in some cases the weight of the tin appliance is unpleasant to the patients, and that it may, partially at least, be replaced by rubber. Prosthesis must of course in all instances be preceded by dental treatment, which is essential both for the maintenance of asepsis, and for the establishment and firmness of the apparatus; the process is also facilitated if models of both jaws are taken before operation.

Sébileau (*Bull. et Mém. Soc. de Chir. de Paris*, 1906, vol. xxxii, p. 1174) recommends a permanent apparatus only after complete cicatrization of the wound, though from the time of the operation the portions of the lower jaw should be kept apart by a temporary wire splint.

REMOVAL OF ONE HALF OF THE LOWER JAW

The usual indication for this operation is the presence of a periosteal sarcoma. Here, no less than in the upper jaw, exploration of a doubtfully malignant tumour is always indicated in order to avoid unnecessary resection of bone.

Operation. The patient is placed in the Trendelenburg position, or in the horizontal position with a firm pillow under the cervical spine, so that the head will fall backwards. Preliminary laryngotomy will usually be unnecessary when the operation is being carried out for removal of a tumour confined to the bone itself; but when adjacent soft parts are implicated, or when it is necessary to remove affected submaxillary glands, laryngotomy is a wise precaution. Similarly, when the operation involves a free dissection of the tissues in the submaxillary triangle, hæmorrhage may be avoided, time saved, and shock obviated by a preliminary ligature of the external carotid artery, which should be carried out below the origin of the lingual and facial branches (see Vol. I, p. 384).

The actual incision will vary with the above-mentioned conditions. Kocher advises the employment of a median incision dividing the lower lip and extending down to the hyoid bone, which will give free access when only the symphysis and the horizontal ramus are involved. He does not recommend the employment of a lateral incision, as he considers that it impairs the mechanism of swallowing by division of muscles and nerves, and so the risk of aspiration pneumonia is increased. When, however, access to the angle and ascending ramus of the jaw is required, or when (as is usually the case in the writer's opinion) it is necessary to remove the submaxillary and other cervical lymphatic glands, Kocher (*Operative Surgery*, translation of 4th edit., p. 105) continues his incision on the side affected 'from the hyoid bone along the submaxillo-cervical crease to a point a finger's breadth behind and below the angle of the jaw, and from thence up to the apex of the mastoid process' (see Fig. 88, p. 190). The level of this incision is insisted upon in order to spare the branches of the facial nerve supplying the muscles in this region.

The flap outlined by this incision is now turned upwards, care being taken to include the muscular structures of the lower lip and chin by keeping as close to the bone as possible. Near the posterior margin of the wound the facial artery and vein must be isolated and divided between ligatures. The glandular contents of the submaxillary triangle are exposed and dissected upwards, so that they may be removed in one piece with the lower jaw. The lower jaw is now divided at or near the

middle line: though it is usually necessary to cut the bone in the mid-line, yet when practicable and without risk of recurrence advantage is gained by making the bone section lateral to the origin of the genial muscles on the side affected; by doing this the movements of the tongue in swallowing and speaking are less likely to be interfered with. Removal of one of the incisors may be necessary, when the jaw may be divided with an Adams's saw; or detachment of the muco-periosteum on the inner surface will allow of the introduction of a Gigli's saw, by which the jaw may be quickly divided from behind forwards.

The affected half of the mandible is now drawn strongly outwards, and the mucous membrane of the floor of the mouth and the attachments of the muscles to its inner surface, namely, the digastric, mylo-hyoid, genio-hyoid, and genio-hyoglossus, are quickly divided. The external surface of the vertical ramus is laid bare by the detachment of the masseter, and by careful separation with a blunt dissector of the soft parts along its posterior margin. The incision in the mucous membrane of the mouth is carried up along the anterior border of the vertical ramus, when the internal pterygoid is detached from its insertion with a knife, and the soft parts are separated backwards with a blunt dissector. Where the superior constrictor has been divided at its attachment to the posterior end of the mylo-hyoid ridge care must be taken to avoid the lingual nerve, which curves forwards at this point. The inferior dental nerve is divided as it enters the inferior dental foramen, and the inferior dental artery lying behind the nerve is divided after ligature at the same spot, the jaw being strongly pulled outwards while this is being done. The bone is now firmly depressed, when a few touches with a knife will expose the attachment of the temporal muscle to the coronoid process; this is carefully divided, and the jaw is pulled down to expose the anterior surface of its neck. Here the external pterygoid will require division, and troublesome hæmorrhage is likely to arise from the masseteric and temporal branches of the internal maxillary artery. The capsule of the temporo-maxillary joint is now more freely exposed with a blunt dissector and its fibres are gradually divided. This, with the detachment of any remaining fibres of the external pterygoid, may be most safely accomplished with a pair of blunt-pointed scissors or by a scalpel kept close to the bone and used in a saw-like manner. In freeing the condyle care must be taken to avoid the internal maxillary artery as it passes between the neck of the jaw and the internal lateral ligament. Preliminary ligature of the external carotid will have eliminated the possibility of troublesome hæmorrhage at this stage of the operation.

As in the case of removal of the upper jaw, so here, fracture is likely

to occur when the bone is extensively implicated by the growth, and this will add to the difficulty of removal of the coronoid process and condyle.

When all hæmorrhage has been arrested, the wound is sponged over with hot saline solution, and the whole raw surface is carefully inspected for remaining fragments of growth. The margins of the wound in the mouth may now be, at least partially, brought together by interrupted catgut sutures, connecting the mucous membrane of the floor of the mouth with the mucous membrane of the cheek. The external skin wound is accurately sutured with interrupted sutures of salmon gut or catgut. When the submaxillary triangle has been freely opened up by the removal of the salivary and lymphatic glands it is wise to insert a drainage tube in the posterior angle of the wound, which may be removed after forty-eight hours.

After-treatment. For the first three or four days the patient must be fed by rectal enemata or by a nasal tube, but during this period a free supply of cold water may be given by the mouth, and the patient may be allowed to suck ice to check capillary oozing. From the first the mouth must be frequently washed out with a weak antiseptic, such as chinosol (1 in 500), and at a later period after each feed given by the mouth the nurse should be instructed to carefully mop or spray the whole region of the wound with the same solution.

Difficulties and dangers. Shock and hæmorrhage, unless the soft parts are extensively involved, are not so severe as after removal of the upper jaw, and for this reason aspiration pneumonia is not likely to occur. The importance of disturbing the muscular attachments as little as possible, so as not to interfere with the patient's power of swallowing, has been previously referred to.

COMPLETE REMOVAL OF THE LOWER JAW

This may be required when both halves of the bone are symmetrically involved by a periosteal sarcoma. The operation is carried out in the same way as that for removal of half the lower jaw by dividing it in the middle line, and removing each half in turn.

OSTEOPLASTIC RESECTION OF THE LOWER JAW

This is a valuable procedure preliminary to the removal of growths, usually malignant, from the floor of the mouth, tongue, tonsil, fauces, and pharynx.

Mesial division of the jaw. When employed as an aid to obtaining better exposure of an epithelioma of the floor of the mouth

or tongue, resection of the lower jaw forms a part of the classical operation of Syme and of Kocher's newer operation, as described in the 4th edition of his *Operative Surgery*, p. 109. By division of the lower jaw in the middle line, followed by separation of the mucous membrane muscles along that side of the floor of the mouth which may in each individual case seem most convenient, free access can be obtained to all the structures between the lips and the posterior pillar of the fauces.

Details of the different operations above indicated will be found elsewhere; here reference will only be made to that part of these operations which is concerned with the lower jaw itself.

With the patient under an anæsthetic and placed in the Trendelenburg position, a median incision is made through the lower lip to a point below the chin. Hæmorrhage from the inferior coronary arteries having been controlled by Spencer Wells's forceps, the soft parts are reflected from the body of the lower jaw for a distance of half an inch on either side of the middle line. The line of the vertical saw-cut to be made through the bone is now outlined by a few movements of the saw, after which a hole is drilled on either side of this notch through the whole substance of the bone, and division of the jaw is then completed with a Gigli's or Adams's saw, when the position of the drill-holes on the inner surface of the bone may be defined by slight detachment of the soft parts laterally. Before proceeding with the operation it is well to locate the two drill-holes for further recognition by passing a short piece of silver wire through each; the two ends of each of these pieces may now be twisted together so as to form a loop on either side, which will form a very useful retractor for the separation of the two halves of the jaw during the later stages of the operation.

When the removal of the growth for which the operation has been undertaken has been completed the two halves of the lower jaw are accurately brought together by a piece of silver wire passed through the drill-holes on both sides. These are now twisted as tightly as possible and cut short, after which the lower lip is sutured.

Lateral division of the jaw. When the tonsil, the pillars of the fauces, and the pharyngeal wall behind these are the seat of new growth, easier access may be obtained by division of the lower jaw at the junction of the body and ascending ramus than by division in the middle line. A similar procedure has been employed by Mikulicz as a step in the operation for neurectomy of the third division of the fifth nerve. The site of bone section may be exposed by Langenbeck's perpendicular incision, which passes vertically downwards from the angle of the mouth, but König prefers to expose the bone by turning a flap of the soft parts

upwards after making a curved incision in the neck, carried from the apex of the mastoid process downwards and forwards to the hyoid bone, and curving upwards towards the chin (see Fig. 89). When the soft parts have been reflected upwards as a flap, the facial artery and vein are ligatured as they cross the inferior border of the mandible. The soft tissues are now raised from the external surface of the mandible, and the mucous membrane of the mouth is divided on its inner aspect, after which the bone is drilled and divided in a similar manner to that described in connexion with the mesial operation. Kocher advises that the line of section should be carried from the lower border upwards and backwards, as, after the parts are replaced, the sawn extremity of the posterior fragment has a tendency to be drawn inwards and upwards by the muscles attached to it.

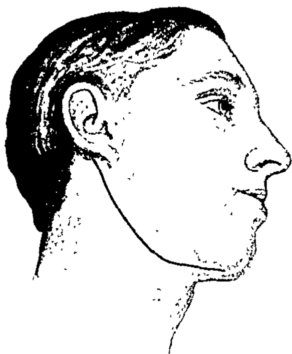


FIG. 89. INCISION FOR LATERAL DIVISION OF THE LOWER JAW IN OSTEOPLASTIC RESECTION. (*After König.*)

PLASTIC OPERATIONS UPON THE LOWER JAW

Indications. Prosthetic operations are required for congenital micrognathia when the diminished rate of growth of the mandible as compared with the maxilla causes the jaw to be underhung, and the inability to approximate the upper and lower teeth results in considerable difficulty in mastication, and often renders it impossible for the teeth to be widely separated. It may also be required for acquired micrognathia, the result either of compression of the developing lower jaw in a child by firm cicatricial contraction of the overlying soft parts or due to extensive necrosis in childhood.

Operation. Von Bergmann is quoted by von Auffenberg (*Langen. Arch.*, 1906, vol. lxxix, p. 594) as recommending resection of both coronoid processes, which in his opinion results in slight improvement in the defective position of the jaws.

Von Eiselsberg (*Langen. Arch.*, 1906, vol. lxxix, p. 594) performed the following operation in a case of micrognathia: A curved incision,

about 15 centimetres long, was made under cover of the chin, extending to the periosteum, and so arranged that the cicatrix was not visible

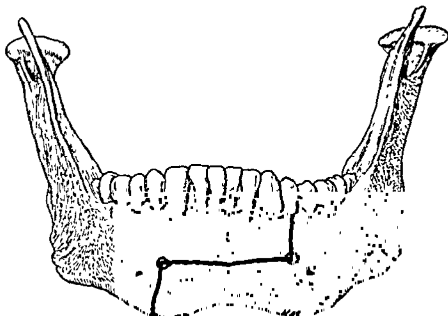


Fig. 90. Lines of Bone Section in Eiselsberg's Operation for Micrognathia.

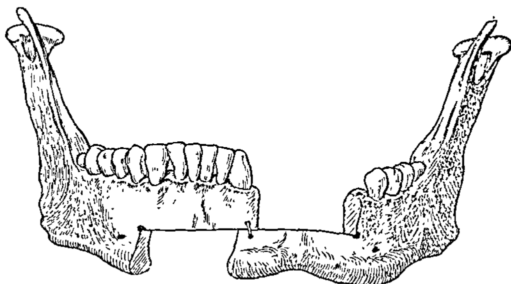


Fig. 91. Later Stage in the same Operation.

from in front. After reflection of the soft parts and extraction of the first left lower premolar, the lower jaw was cut through transversely from above with a fine saw, the cut passing through the socket from which the tooth had been extracted, and extending downwards to

the mid-point between its upper and lower borders. At a distance of one and a half inches anterior to the lower extremity of this saw-cut a hole was drilled transversely, and through this a Gigli's saw was introduced, and a cut was made vertically downwards to the lower border. A horizontal saw-cut was now made to connect the extremities of the two vertical cuts. The segments were then drawn apart and fixed by silver wire sutures introduced through holes drilled near the two newly formed extremities: the process resulted in an increase of about 3 centimetres in the length of the lower jaw (see Figs. 90, 91). The soft parts were sutured and two drains inserted. The cosmetic results were good.

OPERATIONS FOR CLOSURE OF THE JAWS

Various operations upon the mandible have been introduced in order to overcome closure of the jaws, due either to cicatrization of the soft parts or to ankylosis of the temporo-maxillary joint. For the latter condition osteotomy of the neck of the mandible may be undertaken as an alternative to excision of the condyle (see p. 187), and Rochet (Schlatter, *v. Bergmann's Surgery*, vol. i, p. 717) resects a portion of the ascending ramus of the lower jaw, and interposes a flap from the masseter to prevent bony union recurring. Grieg, in order to avoid the branches of the facial nerve, makes an incision at the level of the supra-orbital ridge, running backwards above the malar bone nearly to the external auditory meatus and continued downwards just in front of the tragus to the level of the lobule. This flap is turned downwards and forwards, and the superficial temporal artery divided and ligatured if necessary; the fascia over the masseter is divided, and turned down with the parotid. The jaw can then be freed, from the condyle downwards, when the neck is divided transversely.

Küster for the same purpose makes an incision upon the posterior border of the ascending ramus, to avoid the internal maxillary artery and facial nerve. The soft parts are dissected away from the internal and external surface of the jaw. Access, however, is not so free by this method as by Grieg's incision. Von Bergmann succeeded in improving the deformity of the receding chin by extensive resection of all the processes, and subsequent displacement forwards of the entire jaw by a dental apparatus.

Another method applicable to this class of case is a cuneiform osteotomy, so devised that the base of the wedge is at the angle of the jaw. Mr. Swain's case, referred to below, will serve as a good example of the indications for and results of this method. When the closure of the jaw is due to cicatrization within the mouth, osteotomy of the horizontal

ramus is required, which is best carried out after the manner devised by Esmarch.

Esmarch's operation. **Indications.** For the relief of inability to separate the teeth, due to cicatrization within the mouth or to ankylosis of the temporo-maxillary joint, which cannot be dealt with by excision of the condyle. It is clear that the operation is only applicable to cases where the cicatrices are behind the teeth, as osteotomy can only be successful if carried out in front of the restricting bands.

The beneficial effect of Esmarch's operation is greater when it is only necessary to perform it on one side, and it is held by some that loss of power over the central fragment will usually result from the employment of Esmarch's operation on both sides. Jacobson (*loc. supra cit.*) quotes, as showing that this contention is certainly not universally true, a case operated on by Mr. Swain of Plymouth (*Lancet*, 1894, vol. ii, p. 189), in which, by a modification of Esmarch's operation, a wedge-shaped portion of the lower jaw at its angle was removed on both sides for closure of the mouth after scarlet fever. In this case relapse did not occur and excellent power of control of the body of the lower jaw was retained.

Operation. An incision two and a half inches long is made under the lower border of the mandible, and is placed so that its posterior extremity is in front of the cicatrices which are limiting the movements. When the incision has been carried through the skin the soft parts are raised with the fingers of the left hand, so that the skin wound is drawn up to the bone. The incision is then carried down to the bone, and in doing it the facial artery and vein will usually be exposed, and must either be drawn aside or divided between ligatures. With an elevator the overlying soft parts are carefully and freely raised from the periosteum on both the inner and outer surface of the mandible. The periosteum is now divided on either side of the wedge of bone to be removed. With a keyhole or Gigli's saw a triangular wedge of bone, having its apex at the alveolus, is now freed: the base of the wedge which is formed by the lower border of the mandible measuring at least one and a quarter inches in an adult, and in a child about three-quarters of an inch. Manipulation of the chin will now indicate whether sufficient bone has been removed, and whenever there is any doubt on this question it is better to remove an additional piece owing to the risk of relapse In the section of the bone the inferior dental artery and nerve are of course divided. hæmorrhage from the former is usually not serious, but if necessary it may be controlled by crushing inwards the cancellous bone upon the cut surface of the jaw.

In order to prevent bony union between the two cut surfaces Helferich detached a portion of the masseter, and sutured it between the apposed

surfaces. The wound is now sutured, with or without drainage, after which any teeth loosened during the course of the operation may be removed.

After-treatment. Active and passive movements should be begun on the third day, if necessary under an anæsthetic, and continued daily. The mouth must be frequently washed out with an antiseptic solution, such as resorcin (10 grains to the ounce) or chinosol (1 in 500).

Results. The great tendency after this operation is for relapse to occur. This may be obviated partly by ensuring that a sufficiently large wedge of bone has been removed, and partly by persistence in active and passive movements after the operation. Swain (*loc. supra cit.*) considers that by his modification of Esmarch's operation, if a sufficiently large wedge is removed, the danger of relapse is very remote, but the experience of other surgeons of this operation for cicatrization, such as results from cancrum oris in children, is on the whole discouraging.

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SECTION III

OPERATIONS UPON THE TONGUE TONSILS, PHARYNX, AND ŒSOPHAGUS

PART I

OPERATIONS UPON THE TONGUE TONSILS AND PHARYNX

BY

H. T. BUTLIN, D.C.L., F.R.C.S. (Eng.)
Consulting Surgeon to St. Bartholomew's Hospital

CHAPTER I

OPERATIONS FOR NON-MALIGNANT AFFECTIONS OF THE TONGUE

When I received the courteous request of the editor of this work to undertake the sections relating to the tongue, the tonsil, and the pharynx, I consented to do so on the condition that I should only describe the operations which I myself have been in the habit of performing. Not because I believe my own methods to be preferable to those of other surgeons, but because I knew that I should not be able to devote the necessary time or labour to the task of working up the literature of the subject, and I hoped that the relation of my personal experience, with its failures and successes, might prove sufficiently useful to the next generation of surgeons to compensate for the lack of descriptions of methods many of which I have never seen. The condition was kindly accepted, and I gladly undertook the task, as I desired to draw attention to certain operations which I have been in the habit of practising for many years, but which I have not hitherto described. And, further, it seemed to me that the time had arrived when it would be right to try and discover how far the results of operations for malignant disease could be held to justify the rules of operative treatment which have guided me during the last five-and-twenty years. In order to attain this object, I have been at great pains to complete the histories, as far as possible, of all the patients on whom I have operated for malignant disease of the tongue. So far as I can ascertain, the total number of these patients is 200,[1] and I have analysed the results in such a manner as may, I trust, assist in furnishing answers to some of the many questions which arise in connexion with the operative surgery of this disease. These answers can only be regarded as definite for the time being. Further experience may show that they require modification. Even if this be so, it is good to be able to speak definitely according to the condition of our knowledge at the moment when the questions are suggested.

OPERATIONS FOR ABSCESS

The tiny or larger abscesses which are met with may be incised without hesitation. The incision should be free, as it is very difficult to drain them.

[1] I believe that the following cases comprise all those in which I have operated

It is scarcely ever necessary to tie a vessel, but the edges are brought together with sutures which embrace the entire depth of the incisions, and the wound almost invariably heals completely in the course of three or four days. In place of silk, which I formerly recommended, I now use catgut, made to last for ten days. It has the advantage of not requiring removal.

For many years past I have operated on cases of chronic superficial affections of the tongue which have resisted treatment, and in which ulcers, fissures, and tender areas have formed again and again ; or where

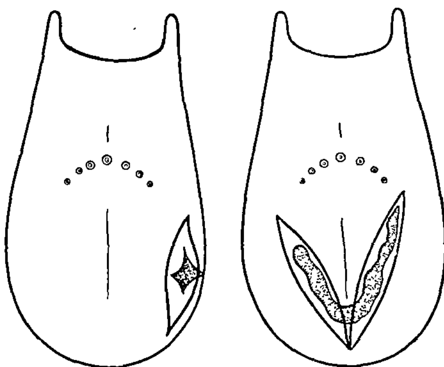


FIG. 92. EXCISION OF AN ULCER OF THE TONGUE. This reproduction is kindly permitted by the editors of the *St. Bartholomew's Hospital Reports.*

thick and threatening areas of leucoplakia have formed. It was at first very difficult to induce either the patients or their medical attendants to agree to operation, such is the dread of any operation on the tongue, both for itself and on account of the expected disability of the patient after the removal of a portion of the tongue. Of late years I have been more successful in persuading patients to undergo these operations, particularly as experience of the earlier cases has enabled me to hold out much more definite promise of success than I could do in the first cases of the kind. Of course, it would be a great advantage if it were possible to rid all patients of such conditions as these, not only on account of the physical distress which they occasion, but also on account of the

Those which occur near the tip and borders of the tongue are probably due to infection from a carious tooth or from the use of a sharp toothpick.

OPERATIONS FOR INFLAMMATORY CONDITIONS

Under this heading are included fissures, ulcers, areas of leucoplakia and ichthyosis, &c., all of them chronic conditions, and some of them probably not having their origin in inflammation, although they have been complicated by repeated attacks of chronic superficial glossitis.

More than twenty years ago I began to cut out chronic ulcers when they would not heal or frequently recurred in the same place. In 1888 I published a paper on the subject (*Bartholomew's Hosp. Rep.*, xxiv, p. 83). Since that time I have operated many times for the removal of such ulcers. The ulcer is cut out between two elliptical incisions, which pass deeply down into the muscular substance of the tongue (see Fig. 92).

for carcinoma of the tongue. The first operation was performed in 1881, and the last in June, 1908.

Died of operation	20
Lost sight of after operation	1
Died of recurrence in the mouth	26
Died of affection of glands without recurrence in the mouth	29
Died of recurrence in the glands without recurrence in the mouth	11
Died of recurrence in mouth and glands	7
Died of recurrence, uncertain whether in mouth or neck or both	10
Died of affection of the glands, uncertain whether recurrence in the mouth	3
Died of recurrence in the glands, uncertain whether recurrence in the mouth	1
Died of affection of glands on other side of neck	2
Died of secondary disease of lungs	1
Died of cancer of the opposite border of tongue	2
Palliative operations (glands too advanced for removal; cancer of tongue only removed)	3
Operation on tongue abandoned	4
Operation on glands abandoned	1
Cases not countable (operations performed within three years; the patients either died of other disease within three years or are still alive and well within three years)	22
Successful (all these patients lived for from three to twenty-two years free from recurrence; most of them are still alive and well)	57
Total	200

The total mortality is 10 %. The proportion of successful cases in the table is 57 in 177, for the 22 cases not countable and the one lost sight of must be deducted from the total of 200. The figure stands therefore at 32·76. Of the successful cases, 8 patients died at intervals of three to fifteen years after the operation; 8 were traced from four to nine years; and 41 are alive and well up to date, from three to twenty-two years after the operation (16 of them more than ten years).

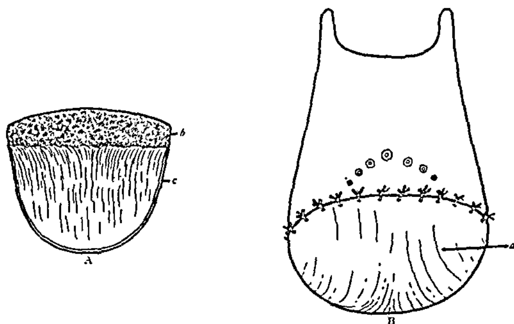


FIG. 95. EXCISION OF CHRONIC DISEASE OF THE TONGUE LIMITED TO THE DORSUM. *Completion of the operation.* A shows the cut muscle surface *b* with the flap *c* reflected from the under-surface. B shows the flap *a* sutured in position.

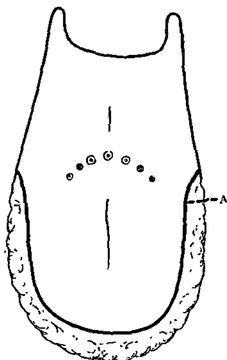


FIG. 96. EXCISION OF CHRONIC DISEASE LIMITED TO THE BORDER OF THE TONGUE. *The dorsal incision,* A.

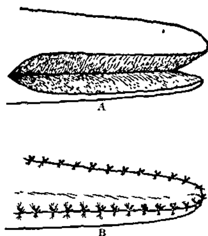


FIG. 97. EXCISION OF CHRONIC DISEASE LIMITED TO THE BORDER OF THE TONGUE. *Final stages.* A shows the gap left after excision of the area, B the method of closing it.

greater liability of such patients to malignant disease. But operation is not applicable to all cases. Some of them are so extensive that they would necessitate removal of a large part of the tongue, of the floor of the mouth, of the gums, and of the inside of the cheeks. So far as the tongue is concerned, the most favourable cases are those in which the disease is limited to the dorsum, or to the borders and tip. The case is better suited for operation if the under surface of the tongue is not affected, as the mucous membrane can then be employed in the remoulding of the tongue.

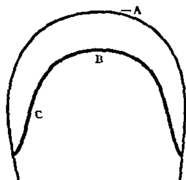


FIG. 93. EXCISION OF CHRONIC DISEASE OF THE TONGUE LIMITED TO THE DORSUM. *The inferior incision.* A, Anterior margin of tongue; B, Lower flap; C, Incision.

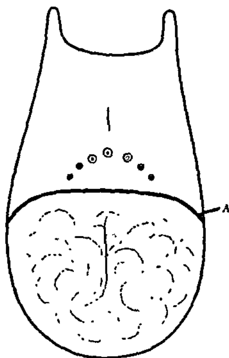


FIG. 94. EXCISION OF CHRONIC DISEASE OF THE TONGUE LIMITED TO THE DORSUM. *The dorsal incision.* A, The incision across the dorsum.

In those cases in which the disease is limited to the dorsum, an incision is carried along below the margin of the tip and borders as far back as is necessary (see Fig. 93). A second incision is carried across the dorsum of the tongue behind the limit of the disease (see Fig. 94). The intervening surface and a good deal of the muscular substance are cut away, and the edges of the incisions are brought together with catgut sutures (see Fig. 95). It is seldom needful to tie vessels, but, if they bleed actively, there is no objection to tying them with catgut. The wound heals rapidly, and speech and mastication are very little affected. It is important not to use the mucous membrane of the under surface without

OPERATIONS FOR SYPHILIS

A prejudice exists against operations on persons whose tongues exhibit signs of past or recurring syphilis, lest the wound should refuse to heal and become syphilitic. I have many times operated on such tongues. Provided the incisions be carried through the unaffected portions of the tongue, the patients seem to recover as well as any other patients, and none of the wounds have become syphilitic ulcers. Even in those cases in which the incisions have been carried through parts which have been the seat of past syphilitic lesions, I have seen no mischief, provided the disease be not progressive and the parts be soundly healed. The prejudice against operations on such tongues does not, therefore, seem to be justified. Indeed, I am disposed to recommend the removal of gummatous masses which do not yield to treatment, but constantly break down and ulcerate. I have had no opportunity during the past few years of applying this suggestion, otherwise I should certainly have done so.

OPERATIONS FOR INNOCENT TUMOURS

WARTS AND WARTY GROWTHS

Warts almost invariably recur if they are only snipped off with scissors. I have known the same wart recur several times until the patient and the doctor began to entertain apprehensions of malignant disease. But, if they are properly removed, there is no fear of their recurrence.

If the wart be very small, it may be destroyed by a single application of a galvano-cautery point, which must be carried well into the base of the wart. Or it may be removed with a galvano-cautery loop without fear of recurrence.

But, if it be of larger size, it should be removed by cutting out the surface on which it grows, and the edges of the wound should be brought together with a single suture of fine catgut.

All these operations can be practised without a general anæsthetic. 20 % solution of cocaine is applied to the surface for two or three minutes, and serves sufficiently to deaden the pain.

ANGIOMA

I have never seen a case of arterial angioma of the tongue, and therefore cannot speak from my own knowledge of the surgical treatment of the disease. Should I meet with a circumscribed area of the disease on the tip or fore-part of the tongue, I should not hesitate to cut it freely out, first clamping the tongue around it and keeping the clamps

a covering of muscle, since some of the flap, and sometimes the greater part of it, will slough, if this precaution is not taken.

In those cases in which the borders only are affected, two parallel incisions are carried round the tip and borders, so as to enclose the whole area of disease and to meet at their posterior ends on each side (see Fig. 95). They are carried well into the substance of the tongue so as to enclose a wedge-shaped piece of muscle (see Fig. 96, A). The edges are approximated (see Fig. 96, B).

In both cases it is very desirable, if possible, to bring the entire area of the cut muscles into apposition. If this be not done, a cavity is left in which blood is apt to collect. There is no difficulty in accomplishing this in operations on the tip and borders of the tongue, but it is much more difficult in those cases in which the operation is performed for disease of the dorsum. In such cases it may be desirable to insert a strip of gutta-percha tissue between the two surfaces in order to ensure the drainage of the wound.

These operations are very successful. Several of them have been performed on members of our profession, to the great advantage of the patients. The removal of the borders and tip in the manner which has just been described results merely in diminishing the size of the fore-part of the tongue, and does not interfere with speech. It is very desirable, in such cases, not to leave a projection at the point on each border where the incisions meet, since such projections are apt to be irritated or even caught between the teeth and bitten.

OPERATIONS FOR MACROGLOSSIA

Limited areas of this disease may be cut out without fear, and in such manner as the seat and extent of the disease may indicate. It is, however, very important to bring the edges of the wound together through their entire thickness, as bleeding is otherwise liable to occur. As most of these operations are performed on children or young persons, this precaution is the more necessary.

OPERATIONS FOR TUBERCULOUS DISEASE

I have made it a practice to remove tuberculous ulcers and lumps in all cases in which the condition of the patient was such as to permit the operation. The ulcers are often extremely painful, and add much to the distress of the patient. The incisions should be carried wide of the disease, but not so wide as for carcinoma, and great care should be taken to approximate the edges of the incision so as to obtain healing by first intention. This is of the greater importance if tuberculous disease of the lungs or air-passages be also present, for open wounds are in grave danger of becoming tuberculous.

The third case was the most interesting of the three, for the tumour in the usual situation at the base of the tongue was continuous with a tumour above the hyoid bone about the size of a small walnut. I dissected the growth out through a single median incision between the jaw and hyoid bone. There was a constriction at the junction of the lingual with the hyoid portions of the tumour, so deep as almost to separate them. The entire tumour, right up through the base of the tongue, was removed without difficulty and without bleeding of importance, and the wound, which was brought together with deep catgut sutures, healed satisfactorily. The structure was precisely similar to that of all tumours of this class which have been removed. Within a short period, the patient began to exhibit symptoms of myxœdema, for which thyreoid extract was necessary. This result was the more unexpected and disappointing because the appearance of the neck and palpation, both before and after the operation, favoured the impression that she was provided with a thyreoid gland in the usual situation. It was therefore hoped that the abnormal gland (the tumour) had been performing all the functions of the normal gland, and that the latter might, in the course of time, take up its proper functions and cause the disappearance of the symptoms. Although three or four years have elapsed since the operation, this does not appear to have taken place. This tumour is preserved in the Museum of the Royal College of Surgeons.

In the presence of this experience and of the somewhat similar experience of Chamisso de Boncourt and Seldowitch (Butlin's *Diseases of the Tongue*, 2nd ed., 1900, p. 253), I have come to the conclusion that these tumours should not be treated by operation lightly.

The mere cutting off the tumour at the base of the tongue in Seldowitch's case with a galvano-cautery loop was followed by symptoms of myxœdema. The discomfort occasioned by the presence of the tumour should therefore be very decided before an operation for its removal is determined on.

in place until the entire surfaces of the wound were brought together with sutures.

I only remember to have operated on one case of cavernous angioma, and the operation was so formidable as to deserve mention. The patient was forty-six years old, and had been accustomed to drink very freely. The whole of the anterior two-thirds of the tongue was transformed into a huge cavernous nævus, which was said to be congenital. But, for some years past, it had gradually increased in size, and recently had become painful and ulcerated. A stout ligature was applied right round the tongue well behind the line of incision, and the whole of the disease was removed. There was no more serious bleeding than is apt to occur in any extensive operation on the tongue; and the patient made a good recovery in spite of an attack of hæmorrhage from one of the lingual arteries about twelve days after the operation. This was easily checked by the pressure of a little strip of gauze inserted into the bottom of the hole in which the mouth of the artery had retracted.

Venous angiomata generally remain of the same relative size during the life of the patient and, unless they bleed, do not call for operation.

FIBROMATA, LIPOMATA, ADENOMATA, ETC.

Any of these tumours may be removed on the same lines as are employed in other parts of the body. The tumour should be dissected out and the edges of the wound should, if practicable, be brought closely together throughout their whole extent and depth. In the few cases which have been under my care, no serious occurrence has complicated the operation.

THYREO-GLOSSAL TUMOURS

In addition to several cases of thyreo-glossal cyst with or without suppuration, I have operated on three cases of solid, or almost solid, thyreo-glossal tumour at the base of the tongue, just in front of the epiglottis. The first two cases occurred nearly twenty years ago, and are described in the *Transactions of the Clinical Society* (xxiii. 118, 1890). I cut and scooped the tumour out in the first case after a preliminary tracheotomy. It recurred in the course of three months, and was larger than when it had been removed. The patient declined a second operation, and, when I examined her six months later, growth appeared to have ceased, and she suffered little or no inconvenience from the presence of the lump.

In the second case I cut the tumour off level with the surface of the tongue with a galvano-cautery loop, heated to a dull red heat. The patient recovered from the operation, and her case has not been followed up.

that it is not likely to recur within the mouth, and to remove the glands which are, or are likely to be, affected. Our operations are, at the present time, directed to accomplish this. Naturally, there is not unanimity of opinion on the exact limits which should be prescribed for the operation; and I shall presently refer to points which are still under discussion, such as the necessity of removing the entire tongue in every case of cancer, the necessity for the removal of the vulnerable muscles down to their attachments in every instance, the necessity for the removal of the tissues which intervene between the primary disease and the neighbouring

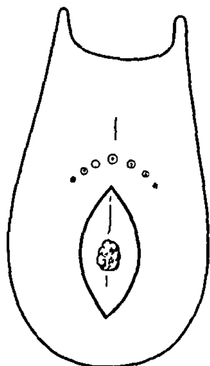


FIG. 98. INCISIONS FOR REMOVAL OF A CANCER IN THE CENTRE OF THE DORSUM OF THE TONGUE.

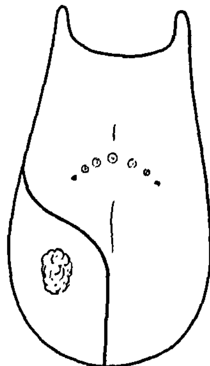


FIG. 99. INCISION FOR REMOVAL OF A CANCER ON ONE SIDE OF THE DORSUM OF THE TONGUE.

lymphatic glands, and the necessity for the removal of the *glands on* both sides of the neck in every case.

My own routine practice is to remove the disease of the tongue very widely, allowing about three-quarters of an inch between the incisions and the apparent margin of the growth (see Figs. 98–100), and to remove the glands on the same side of the neck either at the same sitting or as soon after the first operation as the condition of the patient will permit.

Other forms of malignant disease. I have in two instances removed a disease which was not squamous-celled carcinoma, but which appeared

CHAPTER II

OPERATIONS FOR MALIGNANT TUMOURS OF THE TONGUE

Squamous-celled carcinoma (epithelioma). Although I shall mention other varieties of malignant disease on which I have occasionally operated, almost all my experience is concerned with epithelioma —*the* malignant disease of the tongue. It is of frequent occurrence and the life-history is so nearly uniform in certain respects that every surgeon who deals with it should have its possibilities, as well as its limitations, constantly in mind. It is essentially a disease of the tongue and lymphatic glands in the neck. For, although it may also attack other organs, the cases in which this takes place are so few in number that they may be left out of consideration from the operative point of view. The primary disease begins on or immediately beneath the surface of the tongue, and extends more deeply and more widely as it advances. Mr. Cheatle has shown the manner in which it invades the muscles of the tongue, particularly the hyoglossus, the inferior lingualis, the genio-hyoglossus and the stylo-glossus, and the method of extension by long lines of cancer-cells between the fibres of the muscles far beyond the apparent margin of the tumour must be borne in mind, particularly in those cases in which the disease is somewhat advanced or the margin of the tumour is not very clearly defined. When the growth is on one border or well on one half of the tongue, it will affect the glands on the same side of the neck. When it is in the middle line or near the middle line, it will probably affect the glands on both sides of the neck. But, even when it is absolutely limited to one border of the tongue, it may affect the glands on both sides of the neck—those on the same side first, those on the other side at a later date. Although the cancer-cells must reach the glands through the lymphatic vessels, they are difficult to find there, and do not seem to thrive as the spheroidal cancer-cells do in the lymphatics between the breast and the axilla. The glands are generally affected at an early period, but they frequently escape observation until they are badly affected, owing to the dense structures under which some of the most vulnerable of them lie, such, for example, as the submaxillary and parotid salivary glands.

The problem, then, is to remove the primary disease in such a manner

the operation which I have since practised for tumour in this situation, but I cut the disease freely out after a preliminary laryngotomy. The patient recovered, but recurrence speedily took place, of which he died in the course of several months. So far as I could ascertain, the glands never became involved. It is possible that a large operation through the side of the neck might have been successful. Thus far, the disease seems almost invariably to have recurred *in situ*, and the glands were affected in many of the cases.

If I had to deal with a case of this kind again, I should remove the glands, probably on both sides of the neck, tie and remove the external carotid arteries, and remove the primary tumour through the side of the neck. That might give, at least, a reasonable hope of success. But it is not at all likely that any less severe procedure would be attended with success.

OPERATIONS FOR MALIGNANT DISEASE

Preliminary antisepsis. I have never made the attempt to render the interior of the mouth absolutely free from septic conditions, partly on account of the impossibility of doing this, and partly because both the operator and the patient are anxious to have the operation performed with as little delay as is consistent with safety. But carious teeth and unsound stumps should be treated or removed. If this cannot be carried out during the days previous to the operation, the teeth which are septic should be treated at the time of the operation, when the patient is under the influence of the anæsthetic. If the cancer be ulcerated and foul, particularly if there be a deep cavity, it is astonishing how much it may be improved in the course of a few days by washing it out with an antiseptic lotion night and morning, and keeping it packed with soft iodoform gauze between the washings. The delay of a few days is amply compensated, in such cases, by the cleansing of the ulcer and the increased assurance of a successful issue of the operation. I have not used antitoxin injections, although I was at one time minded to do so. I am, however, again disposed to recommend that they should be used in certain cases : when, for example, the mouth is in an unhealthy condition, and the patient is not a good subject for a severe operation, and in those cases in which it is expedient to remove the disease of the tongue and the glands of the neck at a single sitting. The injection of a solution of the mixed toxins also holds out a more hopeful prospect than the injection of a single toxin, which was the only course at our disposal until recently.

Preliminary laryngotomy. Since the beginning of the year 1900, I have performed this operation in every case of removal of cancer of the

to be undoubted carcinoma, and of the spheroidal-celled variety, which had become partly colloid. The patients were females, and the disease was situated on the border of the tongue, just in front of the attachment of the anterior half-arch of the palate, but not distinctly in connexion with the foliate papilla. In both cases there was an ulcerated tumour. The first case occurred many years ago, and the disease was freely excised. The glands were not removed. The patient is, I understand, alive and well at the present time, nineteen years after the operation.

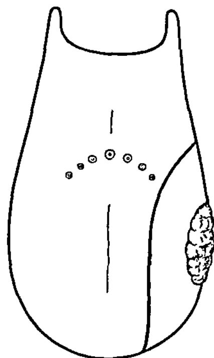


FIG. 100. INCISION FOR REMOVAL OF A CANCER AT THE EDGE OF THE TONGUE.

In the case of the second patient the cancer formed a lump the size of a small walnut, in the upper surface of which there was a hole which led into a cavity. The condition looked so unfavourable that a surgeon who had already seen the patient declined to operate. I removed that half of the tongue and the tissues in the floor of the mouth, and, a fortnight later, took out the contents of the anterior triangle. The glands were not at all enlarged. On section, the tumour had no capsule, but it was more clearly defined than is customary in squamous-celled carcinoma of the tongue. There has been no recurrence in the four years or more which have elapsed since the operation.

As these are the only cases of the kind with which I am acquainted, I am only able to say of them that the disease does not appear to be so dangerous as the common variety of cancer of the tongue.

Sarcoma. The only case in which I have performed an operation for this disease is described in the *Lancet* (1887, i. 623). The tumour was the size of a fives-ball, and was perfectly well defined, but not enclosed in a capsule. It was composed of small round cells. There was no affection of the lymphatic glands. Removal of half of the tongue sufficed to free the patient of his disease, and no recurrence had taken place several years later. The glands were not removed.

Lympho-sarcoma. My only case of this curious disease, situated as usual at the base of the tongue, occurred in a man about sixty years of age. It formed an ulcerated tumour, which bled on several occasions, and to such an extent as to seriously menace the life of the patient. There was no apparent enlargement of the glands. I had not, at that time, designed

A sponge, to which a narrow piece of tape has been fixed, is thrust into the bottom of the pharynx. Two or three such sponges are kept in readiness. For, if the sponge becomes dislodged, it should be taken out and replaced by a clean sponge, not pressed back into its place in the bottom of the pharynx.

Preliminary ligature of vessels. I shall deal with this subject in relation to tumours at the back of the tongue, and will only now say that, if the contents of the anterior triangle are removed before the disease of the tongue, I sometimes tie, not the lingual artery, but the external carotid and its branches, generally above the origin of the superior thyreoid artery.

Position of the patient. After the preliminary laryngotomy, the shoulders are lowered and the head a little raised.

Light. In the absence of good daylight, either reflected light from a laryngoscopic mirror or direct light from a head-lamp is used.

Instruments. In my early surgical days, the écraseur was generally employed, and was rendered much more serviceable and safe by the procedure in connexion with its use which was introduced by my former colleague, Mr. Morrant Baker.[1] It was sometimes replaced by a galvano-cautery loop.

A very great advance in the surgery of the tongue was effected by Professor Whitehead of Manchester, who removed the tongue with scissors. This method held the field for many years, and is still largely followed. It forms the basis of most of the modern operations.

Personally, although I use scissors during certain parts of the operation, I prefer the knife, as a more delicate and certain instrument. No special instruments are needed; only such modifications of ordinary instruments as will naturally suggest themselves as suitable to operations in a cavity, for instance, needles mounted on handles, long forceps, &c.

Either Coleman's gag or a modification of it is one of the best gags. It is introduced on the side of the mouth opposite to the disease. For edentulous and strong-jawed patients, I have had a very large gag constructed on Coleman's model, but it needs to be used with caution on account of its power and the possibility of damage to the jaws.

The tongue is drawn well out of the mouth by means of two or three sutures of tolerably thick silk, which are passed through the fore-part on both sides, and through the back part behind the disease, so as to be free of the intended line of incision.

If the fore-part of the tongue is to be removed, including a portion of both halves, the mucous membrane of the under aspect of the tip may

[1] Mr. Baker showed us how the lingual vessels could be tied in the loop of the écraseur before they were divided.

tongue. In order to help those operators who have only rarely practised it to avoid some of my earlier misfortunes, I venture to recommend certain instruments and a certain method for the performance of the operation.

The shoulders are raised and the head set back, the space between the thyreoid and cricoid cartilages is found, and a transverse incision about three quarters of an inch long is made over it. If the skin be pinched up, above and below, the incision should not wound the superficial veins. Dr. Bond now thrusts a sharp-pointed pair of curved scissors through the intervening tissues into the air-passage, separates the blades, withdraws the scissors, and introduces the laryngotomy tube. I tried this method on his recommendation, but found it somewhat rough, so returned to my own instruments and method. A sharp-pointed curved needle on a handle is pushed through the middle line into the trachea, and upon it first one, then a second sharp-pointed straight director. The needle is withdrawn, the directors are separated by thrusting a smooth-pointed metal instrument between them which permits the introduction of a dilator. This is widely opened, the directors are withdrawn, and the laryngotomy tube on a tolerably sharp-pointed stem is introduced. There is usually no bleeding. The laryngotomy tube is tied in place, and a pair of clamp-forceps is generally fixed on its lower lip in order to allow the tube to be manipulated when its end (as happens in certain cases) is occluded by coming directly in contact with the back wall of the larynx or trachea.[1]

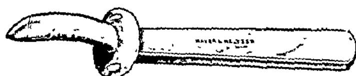


FIG. 101. THE AUTHOR'S LARYNGOTOMY TUBE AND INTRODUCER.

[1] The reasons for using the instruments in the manner which has been recommended are the following —In my early experience of preliminary laryngotomy, I made the incision through the skin, then thrust a sharp-pointed straight director through the cricoid membrane and dilated the opening until the tube could be passed upon its stem. On two or three occasions the tube appeared to pass into the windpipe, but no air came through it, and symptoms of suffocation ensued. The last time this happened I determined to ascertain the reason, and opened up the wound to find that the director had split and broken the cricoid cartilage and thrust a portion of it, with the soft parts attached, back into the windpipe, so that the attempt to introduce the tube had driven it down in front of the end of the stem. A needle on a handle is a much less dangerous instrument, and finds its way easily through the middle of the membrane.

The wound left by the operation is usually quite healed in three or four days. In one instance it suppurated badly for ten or twelve days. In two other cases, emphysema formed around it, which was at once, and permanently, relieved by the insertion of a narrow strip of gutta-percha tissue. I have seen no other complications.

If that be so, the vessel is tied or the wound is effectually plugged with a strip of gauze. No application, either of varnish or of powder, is made to the wound, but the patient is sent back to bed. The laryngotomy tube is removed when he is in bed, sometimes not until he has completely recovered consciousness.

With regard to anæsthetic, I may say that, in the absence of any contra-indication, gas and ether is first administered. After laryngotomy has been performed, chloroform is employed for the operation on the tongue.

During the operation, pads, or, better, natural sponges are used. Sponges cleanse the mouth better than pads.

After-treatment. After such operations as those which have been described, the posture of the patient is of little consequence, and he may either lie on one side, generally the operation-side, with the head low, or may sit up and lean well forward, as appears most comfortable to him.

The mouth is frequently cleansed with glyco-thymolin or some other antiseptic, and the discharges are removed by the nurse with little pieces of cotton-wool. If strips of gauze were inserted they are removed on the day following the operation, and are either replaced each day, if there be a cavity, or are not required in the further treatment of the case. The patient is fed with an ordinary feeder with a nozzle, on which is fixed a piece of india-rubber tubing for comfort's sake. Usually, no difficulty is experienced in swallowing on the day following the operation. The act is painful, and so is the act of speaking ; but the patients are encouraged to feed and speak in spite of the pain, as they recover power at an earlier period over the movements of the tongue. Morphine is administered in most cases a few hours after the operation, and for the first night or two nights, as these operations necessarily cause a good deal of pain.

The wound is usually sufficiently healed in the course of ten days to permit the patient to leave the hospital or nursing home.

These operations are attended with the smallest risk to life, and may be performed on weak and aged persons with scarcely any fear of the result. Many of my patients have been persons between seventy and eighty years of age, and some of them have been notoriously free livers. But I have almost come to regard such operations as free from danger.

Larger operations. When the disease is more advanced, and involves the removal of the entire tongue, it is not sufficient merely to split the tongue and remove the two halves with scissors, after Whitehead's method. The muscles should be removed in a methodical manner. The hyoglossus, the genio-hyoglossus, and the stylo-glossus should be removed on both sides right down to the hyoid bone and back to the styloid process, since Mr. Lenthal Cheatle has shown how deeply they are likely to be infiltrated in such cases. The operation is not difficult. The same pre-

be used. A layer of muscle should be dissected up with the mucous membrane, otherwise sloughing of the flap will probably occur. The operation is precisely similar to that which is described under the heading of Inflammatory Conditions, so that the details need not be repeated (see Figs. 93–95). Nearly an inch of apparently healthy structures behind the disease must be removed, and all the muscle beneath it, with the exception of the thin layer which is dissected up with the flap below.

If half the tongue is to be removed, the mucous membrane should be incised down the middle line to far behind the level of the disease. Some of the mucous membrane of the floor of the mouth may often be dissected up with a thin submucous layer of muscle, and afterwards laid down to cover the lower portion of the wound. An incision is carried along beneath the border of the tongue to a sufficient distance behind the disease, and thence is carried up to meet the incision in the middle line. The portion of the tongue between these incisions is cut out with knife or scissors, and should include a very thick substance of muscle beneath the cancer. The cutting should be carried from below towards the surface of the tongue, and as the vessels are exposed, they should be clamped, if possible before they are cut. They may be tied as they are clamped, or may be left until the operation is complete, but it is easier to tie them before the muscles are severed. No. 00 or 0 catgut, to last ten days, is the best material for ligatures.

Even before the removal of the tongue, the upper and lower surfaces of the fore-part of the remaining half of the tongue are usually brought as nearly together as possible by catgut sutures, so that no open wound is left in front, and parenchymatous and small-vessel bleeding is permanently arrested. After the removal of the half-tongue, the surface of the other half behind the catgut sutures is carefully examined and bleeding vessels are tied. If there be much parenchymatous bleeding, a strip of gauze is fixed to the raw surface by two or three sutures, and the end of the strip is thrust down and back into the space left by the operation. Before these measures are applied, the portion of tongue containing the disease should be carefully examined in order to be sure not only that the cancer has been removed, but to be as sure as possible that it has been widely removed in every direction. If there be the least doubt on this important question, or if the disease appears more formidable after removal than it did before, the muscles should be removed widely in such direction as may seem good to the operator.

The operation is now completed. The mouth is cleansed of blood-clots, the sponge is drawn up from the pharynx, and the cut surfaces are again examined for hæmorrhage. This is important, for the pressure of the sponge may have diminished or arrested bleeding from some small artery.

If that be so, the vessel is tied or the wound is effectually plugged with a strip of gauze. No application, either of varnish or of powder, is made to the wound, but the patient is sent back to bed. The laryngotomy tube is removed when he is in bed, sometimes not until he has completely recovered consciousness.

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liminary measures are adopted as for the removal of a portion of the tongue. It is much easier to remove the tongue in two halves after it has been split. But it should not be split if the split passes through the cancer, for fear of infection of the surface of the wound. If it be important to avoid much loss of blood, the external carotid artery, or the lingual artery where it comes off from the external carotid, may be first tied on both sides, which renders the operation much less dangerous. But, if the glands are to be removed at a later period, the second operation is rendered more difficult by the preliminary ligature of the artery.

After the mucous membrane has been incised all around the floor of the mouth, at such distance from the border of the tongue as may seem necessary, it is raised up off the muscles and the muscles attaching the tongue to the hyoid bone are exposed.[1] They are divided close to the hyoid bone along its entire length. The vessels are secured on the under aspect as soon as they are exposed. If they cannot be dealt with successfully on account of the hindrance produced by the bulk of the tongue, the hæmorrhage can be temporarily controlled by thrusting a pad or sponge far back beneath the tongue on each side until it has been freed and removed by division of the stylo-glossus close to the styloid process. As soon as the vessels have been permanently dealt with, the floor of the mouth must be examined in order to be sure that the hyoid bone is quite bare along its upper border. If any muscle remains, it must be removed. In those cases in which the external carotid arteries have been tied, no ligatures are likely to be required in the mouth. In either case, the mucous membrane is laid down on the floor of the mouth and fixed on the raw surface, and gauze is pressed down into the floor of the mouth to arrest oozing of blood, which is likely, otherwise, to occur to some extent.

When the disease is extensive, but limited to one half of the tongue, and extends into the floor of the mouth, the tongue is split, and the muscles on the affected side are removed right down to the hyoid bone and probably back to the styloid process. The remaining half of the tongue and the floor of the mouth are treated in the manner already described, and the wound is plugged with gauze. Recently, instead of merely tearing the tongue back as nearly as possible in the middle line, I have been much more careful to separate the muscles exactly in the middle line, with a blunt knife-shaped instrument, down to the hyoid bone.[2]

[1] As much of the mucous membrane as possible should be saved, even if the muscle deeper down must be removed. It should be used to cover the raw surface of the wound.

[2] For some of these larger operations, I am sure it would be desirable to divide

If the disease extends across the floor of the mouth to the jaw, it may be necessary to remove a portion of the bone. As the upper part of the jaw, near to the teeth, is most frequently affected, this portion alone may need to be removed. The continuity of the lower part of the jaw is thus preserved, which is a matter of great importance to the patient. In those cases in which the jaw is widely diseased, and the cancer is of considerable bulk, the operation may be more satisfactorily performed through an external incision, and all the contents of the anterior triangle may be removed at the same time.

The *after-treatment* of these larger operations is conducted on the same lines as after the smaller operations, with certain precautions. Thus, I order that the patient shall lie on one side, generally the side of the operation, without any pillow for the head, and with the head rather forward, in order to avert the danger of decomposing discharges making their way into the air-passages. The posture is irksome, but patients will submit to it, if they understand that their lives may depend on its observance. If only half the tongue has been removed, even if the operation has been carried down to the bone, feeding may be accomplished through a feeder without serious difficulty. But, if the entire tongue has been removed, the food must be given through a tube.

For this purpose, it is my custom to use a bulbous urethral catheter, about No. 6 or 7 English. A long piece of india-rubber tubing is fixed to its upper end, interrupted by one piece of glass tubing, and a glass funnel is fixed on to the other end of the tube. For the first few feedings, the throat is previously sprayed with a 5% solution of cocaine. The mouth is thoroughly cleansed of mucus and discharge, the patient lies on his back, and the catheter is passed, in some cases through the mouth, in other cases through one nostril, whichever is more easily tolerated. It is only passed for four or five inches down the œsophagus. In order to be sure that it is in its proper place, and that there will be no dangerous regurgitation, a little water is run through it. The india-rubber tube is pinched between the thumb and finger so that the flow of fluid can be instantly checked. If the fluid descends readily, as it ought to do, half a pint to a pint of warm liquid food is given. During the whole operation of feeding, the fingers should be kept upon the tube, so that it may be

the lower lip and lower jaw in the middle line, as Kocher recommends and practises. If I were beginning instead of relinquishing operative practice, I should use this method in certain cases on account of the better access which it affords to the seat of the disease and the attachments of the muscles. The jaw should be fastened together by wire sutures passed through holes drilled through the bone before it is divided.

At one time I divided the cheek in certain cases. But, since the introduction of preliminary laryngotomy, I have never found it necessary to do so.

compressed in an instant if the patient should cough or feel sick. The rate of flow is regulated by raising or lowering the funnel, and the liquid should be given slowly. Great care must be exercised in the withdrawal of the catheter lest fluid remaining in it pass into the larynx. The tube is compressed until the catheter is quite out of the mouth. The feeding apparatus must be at once cleansed and disinfected, which can be done by running water through it and boiling it for a few minutes. I may seem to have devoted more than necessary space to these matters, but they are vital, and the life of the patient may depend on their observance. In the course of two or three days, the patient, if he be intelligent, will superintend his own feeding, and will himself control the pressure on the tube, and direct whether the fluid shall be allowed to run quickly or slowly.

An experienced nurse can, if she has been trained to do so, manage the tube-feeding after the first day, and this is a great relief to the surgeon, and an advantage to the patient, who is not likely to be kept waiting for his food long after the appointed hour. On the other hand, the feeding should never be entrusted to an inexperienced or careless person. The gauze which was put in at the end of the operation is removed the next day, but is replaced every day for as many days as may seem desirable.

REMOVAL OF A CANCER OF THE BASE OF THE TONGUE

For several years past I have been occupied with this question, and, even yet, am not quite satisfied. The base of the tongue can be reached through a suprahyoid incision. Or it may be reached from the side of the neck after the lower jaw has been divided. But the approach from the suprahyoid space is open to the serious objection that it does not afford a good view of the field of operation, and that it is more than possible the incision may pass through the cancer, and thus render the wound liable to direct inoculation.

Division of the jaw adds to the length of the operation and to its severity, and I do not think it is sufficiently advantageous to compensate for these objections.

What the operator requires is to be able to expose the field of disease in such a manner that no incision is likely to be made into the malignant growth, and, when he has thoroughly investigated the extent and situation of the growth and its relation to the surrounding parts, to be able to remove it in one complete mass, together with, perhaps, the tonsil and part of the pharynx.[1] And he should be able to do this with very little hæmorrhage, with the diseased parts always in view, and without being

[1] If the larynx be invaded and the operator has quite, or almost, made up his mind to remove it, I would recommend Gluck's incisions, and that the operation should begin with the examination and removal of the larynx (*British Medical Journal*, 1903, ii. 1121).

incommoded by or incommoding the anæsthetist, and without fear that blood will escape into the air-passages.

After trying several different methods I have come to the conclusion that the following, as a routine method, fulfils the conditions better than any other.

The disease is generally situated more to one side than the other of the base of the tongue, and may have spread to the pharynx or tonsillar region on that side. At the first operation, the contents of the anterior triangle on that side are cleared out, and the external carotid artery and its branches are excised (see Fig. 105). At the same sitting, the external carotid artery of the opposite side is tied, or may be partly excised with its branches, if the removal of the glands on the other side has been well borne. In the course of ten or twelve days the patient is ready for the operation on the tongue. In my earlier attempts, I opened up the wound on the side from which the glands had been removed, turning up the large triangular flap formed by the incision down the anterior border of the sterno-mastoid and the incision from the symphysis of the jaw to the upper border of the thyreoid cartilage. The flap contained the muscles of the floor of the mouth in addition to the skin. I divided the hyoid bone near the middle line, and turned it up with the muscles, when the hyoglossus had been separated from it. The objection to this course is the difficulty of obtaining adhesion of the edges of the wound in the skin. What with the effect on it of the first operation, the grave interference with the circulation, and the sepsis which is inevitable, a hole may be left in the side of the neck, which is a serious inconvenience to the patient, and retards his complete recovery, perhaps for many weeks.

In my later operations, to avoid this defect, I have attacked the disease from the opposite side of the neck—that on which the external carotid was tied. A large triangular flap, with the point downwards, is made by joining an incision down the anterior border of the sterno-mastoid muscle from the mastoid process to the level of the middle of the thyreoid cartilage, with an incision meeting it almost at a right angle from behind and below the symphysis of the jaw diagonally across the side of the neck (see Fig. 102: 1, 4, 3). The incisions run deep, the hyoid bone is exposed and divided, and is turned upwards and outwards with the muscles forming the floor of the mouth, the mylo-hyoid, the stylo-hyoid and digastric, and perhaps the genio-hyoid, if the incision be at the middle line. But it is better to divide the bone external to the attachment of the genio-hyoid and genio-hyoglossus muscles. An opening is made through the side wall of the pharynx just above the thyreoid cartilage, and is enlarged by cutting the mucous membrane and the hyoglossus back along the upper margin of the hyoid bone.

The incision through the pharyngeal wall is extended in such direction and to such an extent as to afford access to the base of the tongue, and to render the parts which are or may be involved in the disease readily visible to the operator by means of a head-light or reflector. I regard this as essential to the removal of the disease as freely and widely as it is removed in operations on external parts of the body. The more or less blind excision, aided by touch, which I have often practised in the past, should not be relied on if the parts can be presented to the sight, no matter how large an operation may be rendered necessary for the purpose.

The operator should make a thorough examination of the seat and extent of the disease before he proceeds to remove it. He must determine how much of the tongue must be removed in front, and whether the cancer has extended to any part of the larynx or on to the tonsillar region or wall of the pharynx. The disease may then be cut out fearlessly with knife or scissors down to the hyoid bone and thyreoid cartilage, and the incisions must be extended so as to remove deeply and widely any extension of it which has been discovered. The bleeding, which is almost entirely venous, is easily dealt with, and, as a preliminary laryngotomy has been performed and a sponge has been placed at the bottom of the pharynx or, better still, a small sponge has been pushed into the upper opening of the larynx, no blood makes its way into the air-passages. The cut edges of the mucous membrane, where they cannot be joined together, are sewn with catgut sutures to the structures immediately beneath them with the double object of arresting venous oozing and preventing discharges from soaking between the mucous membrane and subjacent tissues. The surface of the wound may advantageously be covered or filled in with gauze, which may need to be kept in place by means of a few catgut sutures. It can be readily removed a day or two after the operation and may be replaced if there be a cavity which can be filled. The stump of the tongue is best treated by tying bleeding veins with catgut, then turning it downwards and forwards and fastening its raw surface to the genio-hyoid and to what may be left of the genio-hyoglossus muscles. In my first operations I feared that all the fore-part of the tongue might slough, or that it might lie an inert mass in the fore-part of the mouth. It did slough in one case, but no harm to the patient ensued. In other cases, only a small portion of it sloughed where it had been cut through. In no case has it lain inert in the mouth. On the contrary, one of my patients was able to move the remains of his tongue freely and even to protrude it from the mouth. An india-rubber tube is passed down the œsophagus and made to protrude from the mouth or nose, not through the wound, as it is of great importance to obtain healing of the wound in the skin as early and as completely as possible.

The sponge is removed from the larynx, but the laryngotomy tube is retained for the first few days. The patient is placed on the side opposite to the wound in the neck, without any pillow for the head, in order to encourage the rapid exit of discharges from the mouth, instead of permitting them to gravitate towards the larynx. The mouth is frequently sprayed and washed out with a weak antiseptic solution, and discharges which still hang about the mouth are frequently removed by the nurse with little pledgets of cotton-wool.

The same posture is maintained until the wound in the mouth is sweet, and the feeding-tube is not removed for many days, perhaps for more than two weeks. When the wound is covered smoothly with granulations, it may be removed, and the patient may be fed as long as is necessary by introducing a catheter for each feed, which can by this time be accomplished without the least difficulty.

The immediate success of these operations has been very remarkable, even in old and feeble subjects, and I approach them almost with the feeling of certainty that the patient will recover. Of the later results, I have no good news to tell. Recurrence has been almost invariable, although it has been deferred in some cases for more than a year. It seems to occur most frequently in the region of the upper part of the larynx, and I have come to the conclusion that, in the present state of our knowledge, the patient would stand a much better chance of escape from recurrence if the operation included the entire removal of the larynx. I have freely cut away the upper part of the larynx, where it seemed only just to have become involved, but that has not sufficed.

In truth, the diagnosis of cancer of the base of the tongue is very far from satisfactory, and the disease has generally eaten deeply into the muscles, or has extended to the neighbouring parts, before it has been discovered. I believe the earliest symptoms are discomfort, referred to the base of the tongue, and increased during swallowing, and the constant hawking and spitting of saliva. I would earnestly direct the attention of practitioners and specialists to the importance of these symptoms and to the necessity of careful and repeated examination of the parts in all cases in which these symptoms are present and persist. I feel sure that ulceration ought to be discovered much earlier than it is. And success in the future must depend on early diagnosis. I believe that Professor Gluck would have succeeded in two or three of the cases in which I have failed, for I have the greatest difficulty in steeling myself to inflict the extensive mutilation which is the only hope of the patient in advanced cases. And every case on which I have thus far operated has been very advanced; so much so, indeed, that I have never gone so far as to counsel the operation, although I have been obliged to admit that it is justifiable,

The incision through the pharyngeal wall is extended in such direction and to such an extent as to afford access to the base of the tongue, and to render the parts which are or may be involved in the disease readily visible to the operator by means of a head-light or reflector. I regard this as essential to the removal of the disease as freely and widely as it is removed in operations on external parts of the body. The more or less blind excision, aided by touch, which I have often practised in the past, should not be relied on if the parts can be presented to the sight, no matter how large an operation may be rendered necessary for the purpose.

The operator should make a thorough examination of the seat and extent of the disease before he proceeds to remove it. He must determine how much of the tongue must be removed in front, and whether the cancer has extended to any part of the larynx or on to the tonsillar region or wall of the pharynx. The disease may then be cut out fearlessly with knife or scissors down to the hyoid bone and thyreoid cartilage, and the incisions must be extended so as to remove deeply and widely any extension of it which has been discovered. The bleeding, which is almost entirely venous, is easily dealt with, and, as a preliminary laryngotomy has been performed and a sponge has been placed at the bottom of the pharynx or, better still, a small sponge has been pushed into the upper opening of the larynx, no blood makes its way into the air-passages. The cut edges of the mucous membrane, where they cannot be joined together, are sewn with catgut sutures to the structures immediately beneath them with the double object of arresting venous oozing and preventing discharges from soaking between the mucous membrane and subjacent tissues. The surface of the wound may advantageously be covered or filled in with gauze, which may need to be kept in place by means of a few catgut sutures. It can be readily removed a day or two after the operation and may be replaced if there be a cavity which can be filled. The stump of the tongue is best treated by tying bleeding veins with catgut, then turning it downwards and forwards and fastening its raw surface to the genio-hyoid and to what may be left of the genio-hyoglossus muscles. In my first operations I feared that all the fore-part of the tongue might slough, or that it might lie an inert mass in the fore-part of the mouth. It did slough in one case, but no harm to the patient ensued. In other cases, only a small portion of it sloughed where it had been cut through. In no case has it lain inert in the mouth. On the contrary, one of my patients was able to move the remains of his tongue freely and even to protrude it from the mouth. An india-rubber tube is passed down the œsophagus and made to protrude from the mouth or nose, not through the wound, as it is of great importance to obtain healing of the wound in the skin as early and as completely as possible.

illustrated in 1905 (*Brit. Med. Journ.*, i. 285). It is performed as follows:— The shoulders are raised on a pillow, the head drawn back and to the opposite side. A long incision is made from the mastoid process to the sterno-clavicular joint, on the anterior border of the sterno-mastoid muscle: another incision is carried across the side of the neck from the symphysis menti to meet the first incision about the upper border of the thyreoid cartilage. It is nearly at right angles to the first incision (see Fig. 102). The skin is thus divided into two large triangular flaps—a lower with its apex backwards, which is turned forwards, an upper flap with its apex downwards, which is turned up over the jaw (see Fig. 103). These flaps should comprise very little more than the skin, as, in addition to the gland over the submaxillary salivary gland, there is another gland in the submental region which also lies in the subcutaneous fat. The dissection begins below, and the sterno-mastoid muscle is drawn a little back (see Fig. 104). Its border is cleaned, so that the muscle is bare.

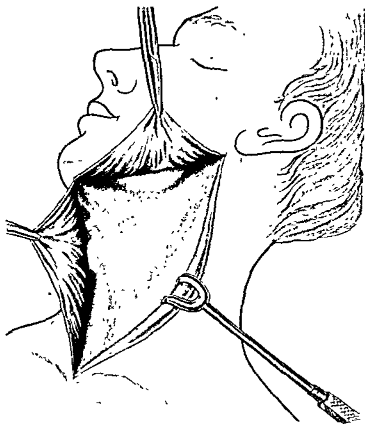


FIG. 103. REMOVAL OF THE CERVICAL GLANDS IN CASES OF TONGUE CANCER. The sketch shows the skin flaps raised.

The dissection is carried down in front of it until the great vessels are exposed. The tissues between the sterno-mastoid and the muscles attached to the larynx, which contain a long chain of glands, are raised, from below upwards, off the great vessels, which are left quite bare at the bottom of the wound. The muscles are cleaned of fascia and fat; the dissection is carried up along the line of the vessels, and quite close to the vessels themselves, otherwise glands may be left behind. It is carried deep down around the vessels, in front and behind, particularly between the parotid gland and the vessels (see Fig. 105). The digastric triangle is

and have been, on that account, called on to perform it. On the other hand, I trust that the experience I have gained of what seems to me an excellent method of exposing the parts involved in the disease, and of dealing with them freely and safely, may be of service to those who follow me, and I have every hope that these operations will be much more successful when the disease has been diagnosed before it has spread wide and deep.

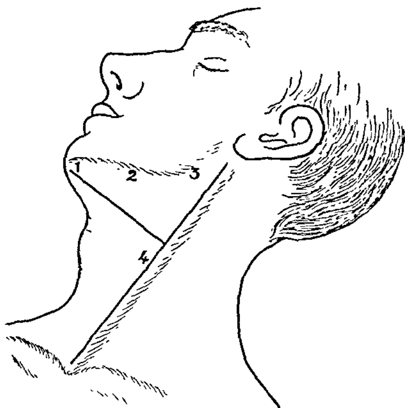


FIG. 102. INCISIONS FOR THE REMOVAL OF THE CERVICAL GLANDS IN CASES OF TONGUE CANCER. The numbers roughly represent the seat of the most important groups of glands, viz. 1, Submental; 2, Submaxillary; 3, Parotid or superior carotid; 4, Gland over the bifurcation of the carotid artery.

This and the three following figures are used by kind permission of the British Medical Association.

THE ROUTINE REMOVAL OF THE GLANDS OF THE NECK

Thirteen years ago (1895), dissatisfied with the haphazard manner in which the glands of the neck were attacked in cases of cancer of the tongue, I devised a routine method of clearing out the contents of the anterior triangle of the neck, founding the method on observations which I had made of the parts of the neck in which enlargement of the glands had occurred in a number of cases of cancer of the tongue. It was roughly described in 1898 (*Brit. Med. Journ.*, i. 541), and described in detail and

to diminish the flow of saliva, which usually takes place for some days after the operation. To facilitate the escape of saliva, and thus to permit the rapid healing of the wound, I now insert a strip of gutta-percha tissue or a fine tube at the upper corner of the wound below the ear. This is a useful precaution. Saliva often escapes at this opening in abundance, so much so that those who perform the operation for the first time are haunted by the fear of a permanent salivary fistula. The fear is quite groundless; indeed, I believe it would be difficult to establish a salivary fistula there, if one were desirous of doing so. On the day following the operation the gauze is drawn out of the wound, but the drainage tube is retained for as long as may seem necessary. Suppuration rarely takes place, and the wound is generally healed in the course of ten days, although saliva may continue to flow from the upper corner for a few days longer.



Fig. 105. Exposure of the Deep Structures of the Neck in Removal of the Cervical Glands.

Some years ago, I left the submaxillary salivary gland in several cases, laying it back in its place after I had removed the lymphatic glands upon and beneath it. This was done for the sake of appearance. The cosmetic result did not, however, satisfy me, and there is no doubt I lost one patient owing to this modification, for a gland or glands which had not been discovered at the operation became cancerous at the lower part of the salivary gland. They were removed, but recurrence took place and killed the patient. I would therefore strongly counsel operators against this practice.

triangle the patient died. At the autopsy, I found an enlarged gland beneath the lower part of the parotid salivary gland, which had not been removed at the operation.

completely cleared out, including the submaxillary salivary gland, and the muscles are left quite bare. The submental region is treated in like manner, and search is made between the genio-hyoid muscles lest a gland there should be overlooked. A very clean dissection can be made in about *one hour and twenty minutes to one hour and three-quarters.* The internal jugular vein and the carotid arteries are exposed for many inches of their course; and the operation is very little prolonged in those cases in which it is expedient to remove the external *carotid artery* with its branches as a preliminary measure. Many vessels need to be tied, and, as the loss of blood is, in most cases, not inconsiderable, it is desirable to clamp and tie as many vessels as possible before they are divided.

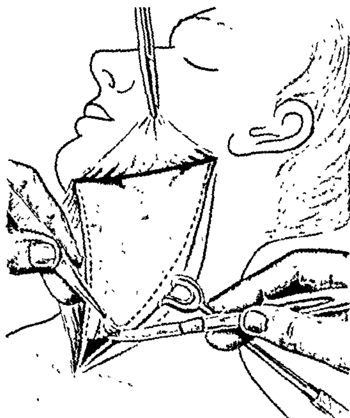


FIG. 104. REMOVING THE GLANDULAR AREA IN CASES OF TONGUE CANCER.

The wound is cleansed of blood-clot, and a strip of gauze is pressed up beneath the jaw in the submaxillary triangle to check oozing, which cannot in that situation be controlled by pressure. The end of this strip of gauze should be carried down over the great vessels and brought out at the lower apex of the wound, and by its side a long drainage tube is placed in order to ensure against collection of fluid in the wound, for gauze seldom acts as a drain; indeed, it more often swells and plugs the exit from the cavity. *For some time past I have made a practice of* sewing up the cut surface of the parotid, the lowest part of which should be removed,[1] with catgut sutures, both for the arrest of oozing and also

[1] The removal of the lower portion of the parotid gland is recommended in order to enable the operator to thoroughly remove the parotid (upper carotid) group of glands. In one of the early cases of removal of the contents of the anterior

cavity is plugged with a strip of gauze, after actual bleeding vessels have been secured with catgut, and the two halves of the lower lip are brought together. The operation should be preceded by a preliminary laryngotomy, in order that the anæsthetist may be able to pursue his task without interruption, and the operator may be able to perform his operation without fear of blood escaping into the air-passages.

If the disease be more extensive, the whole depth of the jaw-bone may need to be removed. In any case it will be advisable to divide the jaw in order to effect the removal with greater certainty of being wide of the growth.

The glands should not be removed at the same sitting. When they are removed, after an interval of twelve or fourteen days, an incision should be carried from the symphysis of the jaw down the middle line to the hyoid bone, then outwards and downwards, first on one side then on the other, to the margin of the sterno-mastoid muscle below the bifurcation of the carotid artery. These incisions may be prolonged down the anterior border of the muscle, if the glands are enlarged over the bifurcation of the artery. The greatest care must be taken to remove the gland behind the symphysis and in the interval between the genio-hyoid muscles, and the contents of the submaxillary region, including the salivary glands, should be removed. If the lymphatic glands in this region are not obviously affected I do not think the parotid lymphatic glands need be removed. But the glands below the submaxillary triangle must be removed, and the dissection must be carried down the line of the vessels until healthy glands are reached and removed.

I believe that an impression generally prevails among surgeons that cancer in this situation is peculiarly dangerous to life. Certainly, that was formerly my own opinion. My personal experience of these cases does not, however, bear out this opinion, as the following figures show :—

Number of cases occurring in my practice	9
Died of recurrence in the mouth	4
Died of affection of the glands without recurrence in the mouth	1
Successful	4
Total	9

The cancer which was not on the frænum was of recent formation and of small size, but, both macroscopically and microscopically, typical epithelioma. It was very freely removed and the glands were not taken out. The patient is still alive and well, twenty-two years after the operation.

In the three remaining successful cases, the disease reached to the bone, but did not involve it. In one of them the disease was widely

When the glands are obviously diseased in the parotid (upper carotid) region, especially if they are beginning to break down, the prognosis of the case is bad; but it may be bettered by removing the glands behind the sterno-mastoid muscle at its upper part, or removing the contents of the posterior triangle.

If the primary disease be so situated as to call for the removal of the glands on both sides of the neck, this may be performed at a single sitting in a sufficiently robust patient, and the same incisions may be practised on both sides of the neck, or the incision may be modified in such manner as the operator thinks fit. Thus, if the primary disease be situated at the fore-part of the tongue or in the floor of the mouth about the frænum, it will probably suffice to remove the tissues as far back as and including the submaxillary salivary gland on each side, without attacking the parotid group of glands, but the dissection must be carried down the neck on each side below the bifurcation of the carotid artery, to be sure that the large gland over the bifurcation is removed; and, if that gland be decidedly enlarged, it is advisable to make a complete dissection of the anterior triangle on that side.

If the patient appears to be too feeble to bear so large an operation at one sitting, the two sides of the neck should be dealt with at separate sittings, with an interval of ten or twelve days.

REMOVAL OF A CANCER LIMITED TO THE FLOOR OF THE MOUTH

In the cases which have come under my care, the disease has been situated, with one exception, at the frænum. In the exception it lay beneath the front of the tongue where it joins the floor of the mouth. Cancer of the frænum generally extends some little distance across the middle line, so that the glands on both sides are in danger of infection. It spreads forwards to the lower jaw, and affects the periosteum and then the bone, unless it is removed before this has taken place. But, at first and for some time, the disease is comparatively superficial and only attacks the bone near the dental margin, and this should be taken into account in dealing with it. The removal, in such cases, can be effected by splitting the lower lip, and turning the halves back on either side. The tooth on either side, at a proper distance from the margin of the disease, is removed, and the bone is cut down through the sockets as deeply as is necessary to reach well below the level of the growth. The intervening bone is cut through with a chisel, so that the lower margin of the jaw-bone is left intact. But the bone, thus loosened, should not be separated from the soft parts behind it. The disease is then as freely cut out as it would be in any other part of the tongue, and the whole, including the detached portion of bone, is taken away in one piece. The

cavity is plugged with a strip of gauze, after actual bleeding vessels have been secured with catgut, and the two halves of the lower lip are brought together. The operation should be preceded by a preliminary laryngotomy, in order that the anæsthetist may be able to pursue his task without interruption, and the operator may be able to perform his operation without fear of blood escaping into the air-passages.

If the disease be more extensive, the whole depth of the jaw-bone may need to be removed. In any case it will be advisable to divide the jaw in order to effect the removal with greater certainty of being wide of the growth.

The glands should not be removed at the same sitting. When they are removed, after an interval of twelve or fourteen days, an incision should be carried from the symphysis of the jaw down the middle line to the hyoid bone, then outwards and downwards, first on one side then on the other, to the margin of the sterno-mastoid muscle below the bifurcation of the carotid artery. These incisions may be prolonged down the anterior border of the muscle, if the glands are enlarged over the bifurcation of the artery. The greatest care must be taken to remove the gland behind the symphysis and in the interval between the genio-hyoid muscles, and the contents of the submaxillary region, including the salivary glands, should be removed. If the lymphatic glands in this region are not obviously affected I do not think the parotid lymphatic glands need be removed. But the glands below the submaxillary triangle must be removed, and the dissection must be carried down the line of the vessels until healthy glands are reached and removed.

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removed, but the glands were not taken out. The patient is alive and well now, at the end of ten years. In the other two cases a strip of the bone was removed, and, at a later date, the glands were taken out. Both these patients remain well, a little more than three years after the operation.

In the five unsuccessful cases, the bone was seriously affected in three, and there was affection of the glands in most of them.

The success which attended two of the operations without the removal of the glands must not be held to excuse the removal of the glands as an unnecessary additional risk. They were cancerous, either at the time of the operation or later, in the majority of the cases.

PRELIMINARY LIGATURE OF SOME OF THE LARGE VESSELS OF THE NECK

Mention has already been made of the use of preliminary ligature of some of the large vessels. Formerly, I was not in the habit of employing this precaution. But since my attention was forcibly directed to it by Dr. Robert Dawbarn of Philadelphia, I have practised it many times.[1]

In all cases in which malignant disease is situated at the base of the tongue, and in some of the cases in which the disease, although not very far back, involves the adjacent parts extensively, the operation may be rendered much less dangerous by the ligature of the external carotid arteries. In such cases the anterior triangle must be cleared out before the disease in the mouth is removed. The carotid artery is laid bare in the course of the operation, and both the internal and external branches are exposed in the wound for a greater or less distance. It is then quite easy to dissect the external carotid artery up to the end branches, and to tie the artery at the highest and lowest points in addition to tying its branches. In fact, I generally ligature the two end branches instead of the trunk. The vessel is cut away between the ligatures. The addition to the operation occupies a very short time and I have never known it attended by untoward results. I would, however, warn operators against applying the ligature quite close to the common carotid, as the proximal clot may extend into the common carotid, where the end of it is liable to be carried as an embolus through the internal carotid into the vessels of the brain.

In cases in which the whole of the base of the tongue has to be subsequently removed, I have then exposed the external carotid artery of the

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opposite side of the neck, and have either treated it in the same manner, or have simply ligatured it.

When the wounds in the neck are healed, or almost well, the disease within the mouth is removed, and the operation is shorn of its chief danger, while there is practically no fear of secondary hæmorrhage.

So far as the cure of malignant disease is effected by the removal of the external carotid artery and its branches on both sides, I have no hope to hold out. The part in which the disease is seated may shrink considerably, but I have not seen sloughing as the result of the operation, nor have I seen a case of cure.

Secondary hæmorrhage. I have come to look very lightly on secondary hæmorrhage from the tongue and floor of the mouth. I do not remember to have ever tied a vessel to arrest hæmorrhage. The routine treatment of hæmorrhage, if it occurs within a few hours of the operation, is to thrust a plug of gauze into the bottom of the wound and entrust it to an assistant, then, having arranged a good head-light or a reflector, to turn out the blood-clot and the plug, and see, if possible, what the bleeding is due to and where it comes from. If a vessel can be distinctly seen, it may be ligatured. But if the vessel be small and difficult to secure, or if the bleeding be parenchymatous, the wound should be thoroughly cleared out and rapidly filled with gauze, which should be pressed down into the bottom of the wound. If it will not hold in place, it must be fastened down by means of two or three strong sutures, fixed wherever they will hold. In place of gauze, a small swab may be used, but I do not recommend it unless the bleeding is very obstinate and not properly controlled by strips of gauze. It swells and is difficult to remove, while the pressure it exercises is apt to produce sloughing of the surrounding tissues.

If hæmorrhage occurs several days after operation, it may also be readily controlled by gauze plugging. In any case, the plugging should be removed every day and replaced day after day until the surface of the wound is healthy and covered with granulations.[1]

[1] Of 197 patients on whom I have operated for cancer of the tongue, three died of hæmorrhage. One of these patients, a man about forty years of age, was a bleeder, and was known by his doctor to be a bleeder. He was desired to tell me this, but he was so anxious to have the disease removed that he concealed his liability. The operation was quite a small one, but he oozed to death in the course of several days in spite of various measures which were taken to arrest the bleeding. One old man of more than seventy years broke out bleeding on the evening of the operation, and bled to death. The wound ought to have been opened up and thoroughly plugged, but this was not done. In the third case, the wound in the mouth became very septic and hæmorrhage occurred again and again until the patient died. Two of these patients were in the hospital, so that they were treated more by the house-surgeon than by myself. But I doubt whether the result would have been other than it was if I had treated them myself.

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General questions. Dealing first with general questions, it will be asked whether the results of operations for cancer of the tongue are better now than they used to be. In 1881, when I performed my first operation, the instrument in general use was the écraseur; extensive operations involving the neighbouring parts (tonsil, pharynx, &c.) and the floor of the mouth were seldom performed; glands were only removed when they were enlarged, and they were then individually dissected out; the mortality due to the operation was about 10% or more, and the cured cases did not amount to 10%. These conditions were very depressing and, as I had the misfortune to lose three out of my first six operations, my own views in regard to the operative treatment of cancer of the tongue were the reverse of hopeful. A comparison of my second 100 (99) with my first 100 (98) cases shows a very great improvement.

COMPARISON OF RESULTS BETWEEN THE FIRST NINETY-EIGHT[1] CASES AND THE SECOND NINETY-NINE CASES

First 98		*Second* 99
11	Died of operation	9
0	Lost sight of after operation	1
16	Died of recurrence in mouth	10
21	Died of affection of glands without recurrence in mouth	8
6	Died of recurrence in glands without recurrence in mouth	4
4	Died of recurrence in mouth and glands	3
6	Died of recurrence, uncertain whether in mouth or neck, or both	4
0	Died of affection of glands, uncertain whether recurrence in mouth	3
1	Died of recurrence in glands, uncertain whether recurrence in mouth	0
0	Died of affection of glands on other side of neck	2
1	Died of secondary disease of lungs	0
0	Died of cancer of other border of tongue	2
0	Palliative operations	3
2	Operation on tongue abandoned	2
0	Operation on glands abandoned	1
7	Cases not countable	15
23	Successful	32
98	Total	99

The mortality due to the operation was almost as large, which at first puzzled me, until I remembered how many large and wellnigh hopeless cases had been undertaken in the second 100, and that there had been

[1] This table was made up before I had completed 200 cases.

SEPTIC AFFECTIONS OF THE LUNG FOLLOWING OPERATION

These have always been and still are the chief cause of death after operations on the tongue. They are generally due to the entrance of blood into the air-passages at the time of the operation and to the entrance of foul discharges, foul air from septic wounds, and food during the after-treatment. They seldom occur after uncomplicated operations for the removal of a cancer of small extent, but they are always to be feared after large and complicated operations. The danger can be reduced in a very large measure by the following precautions, in addition to the means which are taken to keep the wound as free from sepsis as possible :—

(i) Preliminary laryngotomy, which prevents the entrance of blood into the air-passages during the operation.

(ii) The posture recommended at p. 223, with the body on one side, the head low and rather forward, so that discharges tend to run away from, not towards, the larynx.[1]

(iii) The strictest attention to the feeding of the patient, according to the directions on p. 223.

The importance of these three measures cannot be too strongly impressed on surgeons who are engaged in the surgery of the mouth and tongue.

QUESTIONS WHICH ARISE IN CONNEXION WITH OPERATIONS FOR CANCER OF THE TONGUE

Quite apart from the general questions which naturally arise in connexion with any operation which is frequently performed, are certain questions which particularly refer to the treatment of cancer of the tongue.

[1] I wish once more to urge the importance of the posture to be enforced after the larger operations on the tongue. Owing to the large mortality which I experienced in my early operations for removal of cancer of the larynx, I thought over the various means by which the dangers of the operation might be lessened. It had been the custom to allow patients to sit up or to lie in bed with the head raised after these operations. Owing to this posture, there was a constant tendency of discharges, often septic, to trickle or ooze down the air-passages. To prevent this, I made my patients lie on one side, with only one thin pillow or without a pillow, and with the head rather forward, so that discharges tended to run out of, not into, the larynx and air-passages. I began this method of after-treatment about 1890, and described it in the *Proceedings of the Laryngological Society of London* in October, 1893 (1894, p. 28). It is strongly recommended in the second edition of *Diseases of the Tongue*, 1900, p. 376, and in the second edition of the *Operative Surgery of Malignant Disease*, 1900, p. 155. It is irksome to the patient, without doubt, and there is sometimes difficulty in inducing irritable and restless persons to put up with it. But, when it has been explained to the patient that it may make the difference between death and recovery, there are very few persons who will not put up with it for a few days. In operations on the tongue, upper jaw, and upper air-passages, the importance of this posture cannot be too much insisted on.

The two cases in which cancer developed on the other border of the tongue can no more be used as an argument in favour of removal of the entire tongue than the occasional occurrence of cancer in the second breast in favour of the removal of both breasts in every case of cancer of the breast.

Professor Kocher,[1] in support of limited excision for limited cancer as against removal of the 'entire tongue', states that he had only nine local recurrences in thirty-eight cases of recurrence of cancer of the tongue.

I should, therefore, dismiss the question of these very wide removals of the tongue for cancer of limited extent were it not that a new element has been introduced into the discussion by the researches of Mr. Lenthal Cheatle. He has found, in microscopic sections of the muscles at a considerable distance from the primary disease, columns of cancer-cells lying between the fibres of muscles, which look quite healthy to the naked eye. He therefore recommends that, according to the seat of the primary disease, the genio-hyoglossus and inferior lingualis or the hyoglossus or the stylo-glossus muscle should be removed back to its attachment to the bone. In cases of cancer of the anterior part of the tongue and the tip, the genio-hyoid muscle and the fascia covering it should be removed. If the primary disease be so situated as to extend into both halves of the tongue, some or all of these muscles should be

[1] *Chirurg. Operationslehre*, 5th ed., 1907, p. 605. I still see 'Kocher's operation' described in English books and papers in much the same terms as were used to describe it many years ago. The incision and method were designed by Professor Kocher with the definite object of treating cases of excision of one half or the whole of the tongue by Listerian methods. It is certain that for many years past he has only occasionally been in the habit of employing his own incision and method, as they are described by English authors. In the fifth edition (from which I have quoted above) he says that between the years 1890 and 1903 he operated on sixty-two cases of cancer of the tongue: ten of them through the mouth without preparatory operation; thirteen after splitting the cheek; twenty-three after division of the lower lip and jaw in the middle line; four after lateral division of the jaw; three with partial resection of the jaw; and seven from beneath the tongue ('von der Zungenbasis aus'), p. 601. The description of the operation 'von der Zungenbasis aus' on page 610 shows that that is the operation which is generally called 'Kocher's operation'. But he now only uses it occasionally and for cases to which it appears especially adapted. And he particularly points out that a further operation is necessary for the removal of the glands further down the neck. It is very important that those persons who are disposed to practise 'Kocher's operation' should know that the original incision in the neck is not sufficient for the removal of the lymphatic glands, and does not at all satisfy Professor Kocher's present views. In fact, I can find very few differences between his present methods and my own: much more frequent use of splitting of the cheek and median division of the lower jaw as preliminary steps, and a strong disposition to remove the contents of the anterior triangle on both sides of the neck in all cases of cancer of the tongue.

a complete removal of the contents of the anterior triangle, or even more, in 70 out of the last 114 cases. In spite of this, the number of cured cases and the general results are far better in the second 100 cases. The cures run up to thirty-two in place of twenty-three, with more probable successes to be hoped for in the next few years. The number of those who died of recurrence fell from thirty-one to twenty-one, and the number of those who died of affection of the glands without recurrence in the mouth from twenty-one to eight. These last figures are not final, for the total of cured, recurrent, and fatal glands cases will have to be rectified in the course of two or three years from the fifteen cases which are still ' not countable '. But the difference in the present results of the two hundreds allows a very large margin for correction.

Special questions. **Questions connected with the removal of the primary disease.** In other words, how much of the tongue is it necessary to remove ? On this question there always has been, and there probably always will be, considerable difference of opinion. Nothing less than ' removal of the entire tongue ' would satisfy certain operators thirty years ago, and it appears to be still the watchword of a few distinguished surgeons. I shall venture to dismiss it in a few sentences. In the first place, the ' entire tongue ' is not usually removed by those who profess to perform the operation, for large portions of the muscles attaching the tongue to its bearings are habitually left behind. Second, removal of the entire tongue does not guarantee the patient from recurrence in the floor of the mouth or in the tonsillar region, which are much more likely to be attacked in many cases than the other half of the tongue. Third, a large number of persons would be deterred from submitting to operation if they expected to lose the ' entire tongue ' for cancers of small or moderate size, and the burden of proof of the necessity for so large an operation must lie with those who propose it. At present, experience points the other way. It has been my own practice throughout to remove the disease with, if possible, about $\frac{3}{4}$ inch of surrounding healthy tissues. In relation to this point my statistics show the following results :—

Out of the 197 cases there were 99 in which there was no recurrence in the tongue. They are classified as follows :—

Died of affection of the glands	39
Died of affection of the glands on the other side of the neck	2
Died of cancer of the lungs	1
Died of cancer of the other border of the tongue	2
Successful	55
Total	99

lines. For, although the practice of surgery should always depend on the teachings of pathology, it is, on the other hand, very important to be sure that the pathology on which an operation depends is correct. I have always held, and I believe it may be laid down as an axiom, *that if an operation does not fulfil the requirements of pathology and is, nevertheless, exceedingly successful, the pathology which relates to it must be revised: either the observations are incorrect, or the deductions which are drawn from them are not justified.* A reference to the table on p. 238 shows the remarkable success which has attended operations which were wholly inadequate on Mr. Cheatle's theory; and Kocher's cases tell the same tale, which is the more important because he urges operators to be sparing in their removal of these muscles on account of subsequent injury to speech and taking food (*loc. cit.*, p. 607).

Applying the axiom above to Mr. Cheatle's recommendation, I am, therefore, driven to the conclusion that the pathology on which it is based is, in some manner, at fault. Nearly all my cases of early or comparatively early cancer of the tongue have been examined in continuous sections by the Imperial Cancer Research; and Dr. Bashford and Dr. Murray do not confirm Mr. Cheatle's observations.[1] And, as I have successfully

[1] There is one notable exception to this statement, and the case deserves to be related because it has already excited attention in American surgical circles and is reported fully in the *Transactions of the Twenty-eighth and Twenty-ninth Annual Meetings* (1906 and 1907) *of the American Laryngological Association*, by Dr. Joseph Bryan of Washington. The patient was an American gentleman for whom I removed the right half of the tongue to about 1 inch behind the apparent margin of a flat, granular, glazed epithelioma of about six months' duration, on the border. Finding the plaque thicker on section than it appeared before removal, I cut out a lump of muscle in the floor of the mouth beneath it, but made no attempt to remove any of the muscles up to their attachments. The contents of the right anterior triangle were removed two or three weeks later, and Dr. Bryan was present at the operation on the tongue. No cancer was found in the glands, but Dr. Murray said the sections of the primary disease exhibited a very high degree of malignancy, and pointed out to me columns of cells infiltrating the muscle far beyond the apparent limit of the disease. I was therefore fully prepared for local recurrence in this case. But there was none. On the other hand, the high degree of malignancy exhibited in the sections was fully borne out by what afterwards took place. The patient returned to America, and, just within six months of the operation, suddenly found a lump on the left side of his neck, about the bifurcation of the carotid artery. An attempt was made to remove the contents of the left anterior triangle, but very extensive and fixed disease was discovered, and the patient succumbed to an attack of pneumonia and paralysis in the course of a few days. There was no recurrence in the mouth or on the right side of the neck. Dr. Bryan's account of the case in the *Transactions* for 1906 (p. 19) is quite correct. But the following year, in reply to a question, he said, 'Mr. Butlin removed the whole floor of the mouth, deep down into the larynx' (*Trans.*, 1907, p. 214). This statement is not correct. I had it in mind to do so when the glands were removed, but the friends would not agree, and the result proved that they were right.

removed on both sides. As the result of his researches Mr. Cheatle is of opinion that the hyoglossus and genio-hyoglossus and inferior lingualis muscles should be removed in *every* case of cancer of one half of the tongue, even if the primary disease be quite small and in an early stage of its existence. Mr. Cheatle has shown me a number of his specimens, which are beautifully prepared, and which do show columns of cancer-cells extending between the muscle fibres far beyond the apparent margin of the disease. Although the suggestions of Mr. Cheatle would probably not add much to the difficulty or danger of the operation in the hands of an expert, there is, on the other hand, no doubt that the removal of



FIG 106. SECTION OF A SMALL CANCER (DARK SHADING). Slightly magnified.



FIG. 107. SECTION OF MUSCLE BELOW THE CANCER. Showing groups or columns of cancer-cells between the muscle fibres.

[The drawings for Figs. 106, 107 were very kindly supplied me by Mr. Cheatle.]

the muscles to their attachments seriously impairs the powers of speech and taking food.[1] I therefore determined, before embarking on a new scheme of operation, to discover what measure of success had attended a large number of operations which had not been performed on these

[1] I have convinced myself of this by following Cheatle's suggestion in a few cases.

ANALYSIS OF THE SEVENTY CASES IN WHICH THE CONTENTS OF THE ANTERIOR TRIANGLE WERE REMOVED

Died of the operation	6
Lost sight of after operation	1
Died of recurrence in the mouth	9
Died of recurrence, uncertain where (in one of these the glands could not be entirely removed; operation abandoned)	7
Died of recurrence in the glands (in one of these the submaxillary salivary gland was left and the disease recurred beneath it; in the other seven cases the glands were enlarged at the time of their removal, and in five of these they were demonstrably cancerous)	8
Died of cancer on the opposite side of the tongue	1
Died of affection of glands on opposite side of neck	2
Died of other disease within three years	1
Cases not countable	11
Successful cases	24
Total	70

The number of persons who are known to have died of recurrence in the glands on the same side is only eight, but it is probable that several of those who died of recurrence, 'uncertain where,' should be added to the eight. The successful cases number twenty-four, and there are several others out of the eleven 'not countable' cases which may by-and-by be added to them. The presumption is evidently in favour of the operation.

(ii) *Should the operation be performed in every case of cancer of the tongue?* May not the very early cases be allowed to pass, and is not cancer of some parts of the tongue less dangerous in this respect than cancer of some other parts? Very small and, presumably, recent cancers were removed in eighteen of my cases, and from different parts of the tongue. No fewer than six of the patients died of affection of the glands without recurrence in the mouth. One of the smallest cancers I have ever seen[1] was successfully removed by quite a trivial operation, but proved fatal more than three years later by involving the corresponding lymphatic glands.

In order to discover the influence of the seat of the primary disease,

[1] Figured in the 2nd Scientific Report of the Imperial Cancer Research, p. 45, Fig. 35, 1905.

removed much larger cancers beneath and behind which the muscles probably did contain lines or columns of cancer-cells beyond the limit of my incision, I can only form the conclusion that these groups of cells failed to thrive and multiply in the substance of the muscles. At present, therefore, I am not prepared to go further than to recommend the adoption of Mr. Cheatle's method in the more advanced and extensive cancers, particularly when the muscles are obviously deeply invaded by them.

Questions connected with the removal of the glands. (1) *Has the removal of the contents of the anterior triangle thus far justified the practice as a routine operation?*

Although the number of cases in the following comparison is not large, I think it is sufficiently large to justify the expression of an opinion.

In the year 1895 I began the routine removal of the contents of the anterior triangle. Out of 114 cases since that time, I removed the contents of the anterior triangle in 70, and did not remove them in 44 cases.

Analysis of the Forty-four Cases in which the Contents of the Anterior Triangle were not removed

To these should be added 8 cases in which the patients returned at a later period for removal of enlarged glands, which were not intended to be removed when the tongue was treated, making a total of 52 cases.

Died of operation	6
Died of recurrence in the mouth (in 3 of these the operation was abandoned)	7
Died of affection of glands (in 5 of these the glands were enlarged at the time of operation on the tongue, but were not removed for various reasons)	15
Died of cancer of opposite border of tongue	1
Cases not countable	3
Successful cases	12
Total	44

In 52 cases there were 23 (15+8) in which the glands either were affected at the time of the operation (5) or became affected later (18). The successful cases were 12 in number, and there are 3 cases still not countable. Eight of the cases in which the glands became affected afterwards are included in the following table —

(iv) *When should the operation on the glands be performed?* I have formed a very strong opinion that, in the absence of a decided indication to the contrary, the tongue and the neck should not be operated on at the same time. Of course there are cases of small cancers and strong patients, in whom it would be almost absurd to operate at two sittings. But, in most cases, the double operation is a great strain upon the patient, the neck wound is liable to be fouled and suppurate, and the risk to life is much greater than when the operation is performed at two sittings.[1] As a rule, the operation on the tongue takes place first and the operation on the neck as soon as the wound in the mouth is free from sepsis and the patient can take food easily. But there are cases in which the glands may be advantageously treated first; when the external carotid artery or some of its branches can be tied, and the second operation thus made much more easy and less dangerous. The operator must decide for himself whether to treat the tongue or the glands first.

(v) *Is the removal of the contents of the anterior triangle as a routine operation sufficient?* I have already (see p. 231) suggested that the removal should include the submaxillary salivary gland in every case; that the dissection should be carried well up into the parotid region,

maxillary salivary gland was not removed, but was raised up for the removal of the glands beneath it. Recurrence took place in the lower part of the salivary gland, presumably due to affection of a lymphatic gland which had been overlooked.

[1] The results of 'single' sitting and of removal of the glands at a 'separate' sitting are shown in this table:—

Single sitting:	
Glands enlarged	12
Glands not enlarged	10
Total	22
with four deaths due to the operation.	
Separate sitting (shortly before or after operation on the tongue):	
Glands enlarged	16
Glands not enlarged	22
At a later period:	
Glands enlarged	8
Glands not enlarged	2
Total	48
with two deaths due to the operation.	

In one of the two fatal cases the operation upon the glands was undertaken twelve days after the operation upon the tongue, and a further portion of the tongue was cut out because I feared I had not removed sufficient at the first operation. This further portion was in the floor of the mouth, and the entire wound in the neck became septic.

I made an analysis of a number of cases [1] which points strongly to the belief that, although the anterior portion of the dorsum may perhaps be less dangerous to the glands than any other part, it would not be wise to act as if it were so. At present, I believe the proper course is to remove the glands in every case of cancer of the tongue in which there is reason to believe the patient will recover from the operation.

(iii) *Is there any advantage in postponing the removal of the glands until they are enlarged?* I desire particularly to protest against this suggestion which was put forward in a well-known work on Surgical Treatment in 1902. The great hope of success lies in early removal of the glands. The operation is easier and the results are better.[2]

[1] In 23 cases out of the entire series of 197, only the primary disease was removed, but the patients remained free from recurrence *in situ* and from affection of the glands (successful cases).

The seat of the disease, roughly noted, was as follows:—

Dorsum:	
Anterior	8
Further back	2
Border:	
Near the tip	1
At various points	4
Beneath the border	7
Tip:	
Under surface	1
Total	23

For comparison with these cases, I have taken 23 cases (between the 87th and the 197th) in which the glands were not removed, but became affected at a later period:—

Dorsum:	
Anterior	4
Border:	
Near the tip	5
At various points	9
Beneath the border	2
Frænum	2
Extensive disease	1
Total	23

[2] For the consideration of this question, 56 cases, in which the results are known, may be used.

Glands enlarged at the time of operation, 34:	
Died of recurrence in the neck	7
Successful	11
Glands not enlarged at the time of operation, 22:	
Died of recurrence in the neck	1
Successful	13

It will be seen that the evidence is largely in favour of not deferring the operation until the glands are enlarged.

In the single case of recurrence in the neck in the second series, the sub-

(iv) *When should the operation on the glands be performed?* I have formed a very strong opinion that, in the absence of a decided indication to the contrary, the tongue and the neck should not be operated on at the same time. Of course there are cases of small cancers and strong patients, in whom it would be almost absurd to operate at two sittings. But, in most cases, the double operation is a great strain upon the patient, the neck wound is liable to be fouled and suppurate, and the risk to life is much greater than when the operation is performed at two sittings.[1] As a rule, the operation on the tongue takes place first and the operation on the neck as soon as the wound in the mouth is free from sepsis and the patient can take food easily. But there are cases in which the glands may be advantageously treated first; when the external carotid artery or some of its branches can be tied, and the second operation thus made much more easy and less dangerous. The operator must decide for himself whether to treat the tongue or the glands first.

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with the removal of the lower portion of the salivary gland in most cases; and that the glands beneath and behind the sterno-mastoid muscle should certainly be removed in those cases in which the glands in the parotid region are gravely affected.[1]

It is the practice of some surgeons to remove the contents of both anterior triangles in all cases in which the patient will submit to the operation. Up to the present time I have only performed the double operation on special occasions. The following conditions appear to justify it :—

(i) Those cases in which the glands on both sides of the neck are enlarged.

(ii) Those cases in which the glands are affected only on the side of the neck opposite to the disease.

(iii) Those cases in which the disease is seated on both sides of the tongue, or in which it reaches to the middle line of the tongue.

(iv) Perhaps it ought to be done in those cases in which microscopical examination gives reason to believe that, although the primary disease is apparently only of small extent and depth, it is much more malignant than usual—when, for instance, columns of cancer-cells are found running deeply down between the muscular fibres.

I am not disposed to recommend the removal of the contents of both anterior triangles until stronger proof can be furnished of the necessity of the double operation than is now before me.[2]

[1] In my seventy cases there were very few in which the dissection was carried to the extent of removing the contents of the posterior triangle or of dividing the sterno-cleido-mastoideus. Yet there were only eight cases in which the disease was noted to have recurred in the neck alone.

In one of these the recurrence took place owing to the omission to remove the *submaxillary salivary gland. And in the other seven cases the glands were enlarged* at the time of the operation; in five of the seven they were macroscopically and microscopically cancerous.

[2] The cases of which I have notes are not sufficient in number for the decision of this question. There may have been other cases, among those of which the further history is imperfect, in which the glands were affected on both sides of the neck. So far as the records go, they do not favour the view of the necessity of subjecting every patient to the removal of the glands on both sides of the neck. They are as follows :—

Cases in which the glands were affected on both sides of the neck 9

In six of these nine cases both sides of the tongue were affected by the primary disease.

In the other three cases the primary disease was of one border of the tongue, and in one of the three was some distance from the tip.

Cases in which the glands were affected only on the side opposite to the disease . . . 3

In one of the three the primary disease was near the tip, and in another of the

(vi) Closely bound up with the question of the routine removal of the contents of the anterior triangle is *that of removal of the tissues between the primary disease and the lymphatic glands.* It may be said that the aim of the modern surgery of cancer is to remove the primary disease and the lymphatic glands, together with the intervening tissues, whenever this is possible. It is quite feasible in most cases of cancer of the tongue, and the reasons why it is not generally adopted are that it would necessitate extensive operation on the tongue in every case, however small and limited the cancer, and that the large wound in the neck would almost invariably become septic owing to its communication with the mouth. In spite of these disadvantages, which mean a larger mortality due to the operation and much greater permanent impairment of the mobility of the tongue, I observed a decided leaning towards this method on the part of some of the surgeons who were at the Congress of the International Society of Surgeons at Brussels last year (1908). I am very much opposed to the practice, and would only employ it in those cases in which the primary disease passes deeply down into the floor of the mouth and involves the bone, the salivary gland, and other structures. The operation in separate parts is at present justified by the results and by the infrequency with which cancer is found in the lymphatic vessels of the intervening tissues.[1]

In conclusion I would urge all those who are interested in the surgery of cancer of the tongue to do everything which lies in their power to advance our knowledge of the characters of the disease in its earliest stages, for the hope of the future lies in the treatment of

three it was about one inch from the tip. In both those cases the glands were removed from the opposite side of the neck only, and those two patients are alive and well many years after the operation.

Cases in which the glands on the opposite side of the neck became diseased after successful removal of the primary disease and the glands on the same side	2

In both these cases the primary disease was situated on the border of the tongue, and was of rather small extent. It was some distance back on the border in both cases. It showed microscopic signs of excessive malignancy in one of the cases.

[1] Out of seventy cases in which the anterior triangle was completely cleared out, and a number of other cases in which glands were simply dissected out because they were enlarged, I have very rarely removed the primary disease and the glands in one continuous mass. Yet twenty-nine of these cases proved to be successful. And out of a large number of the unsuccessful cases, in which recurrence took place either in the mouth alone or in the mouth and neck, and in which the seat of the recurrence was noted, there are only two in which it could reasonably have been attributed to affection of the tissues which were left behind between the primary disease and the glands.

those conditions. I have operated on eighteen of such cases up to three years ago, and the results are :—

Recurrence *in situ*	2
Died some years later of cancer of the opposite border of the tongue	2
Died of affection of glands without recurrence *in situ* .	6
Successful (glands removed)	2
Successful (glands not removed)	6
Total	18

Recurrence *in situ* took place in two, one of which was a very virulent case and the other occurred in the early years of my operations. The operation was quite successful in eight cases, and might have been successful in many more if the glands had been removed in every instance.

CHAPTER II

OPERATIONS UPON THE TONSIL

OPERATIONS FOR SUPPURATION OF THE TONSIL

WHEN an acute inflammation of one or both tonsils increases in intensity in spite of the early use of guaiacum and the application of cocaine, the result is, in most cases, suppuration. Both tonsils may suppurate at the same time or one after the other; or there may be more than one abscess present at the same time, or successive suppurations may occur in different parts of the same tonsil in the course of several days. When it is further taken into account that the presence of pus may be diagnosed when there is no pus, or that the collection of pus may be so small that it may be missed by the knife, there will be no difficulty in explaining the disappointment which is not uncommonly experienced in the surgical treatment of quinsy. It is the custom, if a tonsil is to be punctured, to paint it with a strong solution of cocaine, but I doubt whether this really does much to allay the pain of the operation; the inflamed parts are not favourable to the action of cocaine. The surgeon then sits in front of the patient, accoutred with a laryngeal mirror and armed with, by preference, a rather large cleft-palate knife, the handle of which is long and the blade short, so that there is no occasion to cover any part of it with strapping. He picks out the most prominent part of the swollen tonsil, where it just pits under the pressure of the tip of the finger, and, whether it be the bare surface of the tonsil or the tonsil covered by the palate or anterior half-arch, he boldly plunges the point of the knife into it, and in withdrawing the knife cuts, as a rule, upwards and inwards. Sometimes the pus flows out in abundance; the patient is relieved and the heart of the surgeon is rejoiced. Hot water is ordered as a frequent gargle, soft solid food can soon be swallowed, and, in the course of a few days, the storm is past.

But what surgeon who has treated many cases of quinsy does not know the case in which no pus follows the freest cutting of the very spot where the pus ought to be; or the case in which there is nought but blood; or the case in which there is only a colouring of pus upon the knife (sometimes seen by no other person than himself); or the case in which even *he* cannot see the colour of pus; or, once more, the

case in which pus escapes and the patient is little or not at all relieved, or, being for the time relieved, is no better on the following day than on the day before the operation? In my time, I have experienced every one of these disappointments, and the lessons to be learned from them are the following:—not on any account to shrink from the attempt to let out pus where the symptoms point decidedly to its presence, but not to be too sure that pus is present or will certainly be found, and not to promise that the operation will be attended with immediate and permanent relief.

REMOVAL OF THE TONSILS

By the galvano-cautery. There are certain cases in which chronic enlargement of the tonsils is more safely treated by the electric cautery: as, for instance, enlargement of the tonsils in bleeders or persons who are known to be disposed to bleed more than they should do from slight wounds or after the extraction of teeth; some cases of follicular concretions in the tonsils; some cases of slight enlargement in adults, and cases in which only a small portion of a tonsil is enlarged. Hæmorrhage is so much more to be expected after the removal of the tonsils of an adult, that some operators prefer the galvano-cautery to any other method in all cases which require radical treatment in adults.

The method itself is very simple. The tonsil is painted with a strong solution of cocaine, care being taken to apply the cocaine in the follicles which are to be treated, and a porcelain burner at a dull red heat is thrust slowly into the follicles. Several sittings are required for the destruction of tonsils of moderately large size.

I confess that I am not devoted to this method of treatment, which is slow and often attended with a good deal of pain during, and for some time after, each sitting.

By tonsillotomy. The tonsils are removed with scissors, with a bistoury, with the wire loop, used hot or cold, and with the guillotine. In all ordinary cases, the guillotine is the instrument of choice, and Mackenzie's modification of Physick's instrument is that which I have been in the habit of employing. The removal of a prominent pair of tonsils with this instrument, when the tonsils are not adherent to the half-arches and particularly when they are a little constricted at the base, is a very simple proceeding and, in competent hands, is brilliant to witness. The tonsils are freely painted with 20% solution of cocaine. The patient is placed in front of a good light, or the light is reflected from a head-mirror. The head is held between the hands of an assistant, who presses each tonsil in turn inwards with his fingers thrust in behind

the angle of the jaw. A separate guillotine is used for each tonsil. That containing the first tonsil is laid aside, and, before the patient has closed his mouth, the second guillotine is applied and the tonsil is cut off. The whole operation takes less than a minute, and there is usually very little bleeding. No antiseptic treatment is used before the removal of the tonsils, for it is quite impossible to render the field of operation aseptic. The only precautions in this respect which should be observed are, to avoid operations, if possible, during actually existing septic affection of the throat, and to sterilize the guillotines by boiling. And no special after-treatment is required other than will occur to any person of common sense. Tonsillotomy, in children or young adults, is welcomed by every surgeon who is in the habit of removing tonsils with the guillotine. The dexterity and quickness which are acquired by most operators on the throat, and the completeness of the removal, offer a charm to all young surgeons and are welcome to surgeons of long experience.

Dangers. But even in the simplest cases accidents are liable to occur, and it is of these I wish to speak.

Incomplete severance of the tonsil. The tonsil ought to come out fixed to the rim of the guillotine, but it occasionally happens that the blade slips back slightly before the guillotine is withdrawn, and the tonsil is left in the throat. It is generally completely severed, and may be swallowed by the patient before it can be coughed out or hooked out by the finger of the operator. But it may not have been completely severed and may still hang by a strip of mucous membrane.[1] In order to avoid this accident, the thumb should be kept firmly pressed against the end of the blade until the guillotine has been withdrawn.

Hæmorrhage is the constant dread of every surgeon who is frequently engaged in the removal of tonsils. It may occur at the most unexpected times, and, so far as I have observed, occurs in one of three different conditions. *First*, the removal of the tonsil is immediately attended

[1] In one case this accident was attended with consequences which might have been serious, had not competent assistance been at hand. At the close of one afternoon, in the Out-patient Department, I removed a pair of very large tonsils for a little boy, with the help of the only remaining dresser. The first tonsil came out complete. But when the second guillotine was withdrawn the tonsil was not in it. The child instantly became asphyxiated, and I feared the tonsil had fallen into the larynx. I felt with my finger and found that it lay over the upper opening of the larynx and that it was not detached at the lower part. I tried to hook it out, but did not succeed, and again the child was choked. I at once held the child up by the legs, when the symptoms of asphyxiation ceased. Further assistance and a chloroformist were called for, and the child was held with the head hanging a little down until sufficient chloroform had been administered to allow of the introduction of a gag and the separation and removal of the tonsil.

with violent hæmorrhage. If this be venous, there is little to be feared. But if it be arterial it may result in instant death. I have never seen a case of this kind, but I have read of them, and the cause of the hæmorrhage has been stated to be an abnormal course of one of the large arteries of the neck, which has been actually wounded by the guillotine. The only chance of saving life, in such a case, would seem to be to thrust the end of the finger or a small pad forcibly into the hole left by the removal of the tonsil so as to arrest the hæmorrhage until assistance and an anæsthetic are procured, and to open up the neck from the outside and attempt to find the bleeding vessel. How very seldom such a course of action would be practicable, every surgeon will judge.

Second, hæmorrhage may take place suddenly and violently some days after the operation, and such hæmorrhages may be more than once repeated. In the few cases in which I have known this to occur, the bleeding has ceased spontaneously, often as suddenly as it began. The hæmorrhage has not been repeated, or each repetition has been attended with the same conditions, until the patient has completely recovered with no worse mischief than a more or less considerable loss of blood. Probably, some septic condition of the throat has been the primary cause of the accident. I have never found it necessary to adopt any surgical procedure in any case of the kind; but the patient should be kept in bed and lying down, and every care should be taken to cleanse the throat and prevent the collection of decomposing blood and discharge.

Should the hæmorrhage continue in any such case, or should it appear very desirable, on account of the condition of the patient, to take special precautions to arrest the continuance of the bleeding or to guard against recurrence, I believe the best procedure is to clear out the blood from the hollow under a general anæsthetic, to pack the wound carefully with gauze, and to fix the gauze in place by means of two or three sutures carried by means of a curved needle on a handle through the pillars of the fauces.

Third, hæmorrhage may continue steadily for a considerable period after the operation. The hæmorrhage is not necessarily rapid, but it may continue at a steady rate until a large quantity of blood has been lost. In such cases various styptic applications have been recommended, and pressure with the finger or with a firm pad at the end of a piece of stick. And ligature of the common carotid artery has been performed or, sometimes, ligature of the external carotid. During the early period of my practice in diseases of the throat at St. Bartholomew's Hospital, knowing that I might at any time be brought face to face with serious hæmorrhage after the removal of the tonsils, and that I ought to be prepared to meet the emergency with some degree of

confidence, I made a careful study of the literature relating to such cases, particularly of those in which heroic measures had been adopted, with the conclusion that the only cases in which they were justifiable were those in which sudden and violent hæmorrhage immediately followed the performance of the operation. In those cases, however, death usually occurred so quickly that, unless the operation had been performed in an operating theatre, with skilled assistance at hand, there was no time or opportunity for ligature of one of the large vessels. In the cases in which long-continued and steady bleeding followed on the operation, and the operator, not being able to check it by more simple measures, had resorted to ligature of one of the large vessels, I was led to believe that the operation had not been necessary and that the bleeding would have ceased spontaneously, without a fatal result, if the ligature had not been applied. Two circumstances, in particular, led me to this opinion. One of my senior colleagues, who had been Surgeon to the Children's Hospital in Great Ormond Street and had therefore been in the habit of frequently removing the tonsils of children with Fahnestock's guillotine, with which he was more dexterous than any surgeon I ever saw, told me that he had had a case of hæmorrhage in his private practice after the removal of the tonsils of a child. The hæmorrhage was so violent that he could not but believe that one of the large arteries had been wounded. Pressure seemed to have no effect upon it and, believing that the child was immediately about to die, he called the mother into the room that she might be present. But as he did so, the child became collapsed, the bleeding instantly ceased, and this was followed by the recovery of the patient.

The other circumstance was that the records of cases in which the common carotid artery had been tied showed that the bleeding had not always ceased on the application of the ligature, but had continued, much as before, until the patient fainted from loss of blood, when the hæmorrhage was stayed. I could not but believe that a very large and serious complication which was wholly unnecessary had been added to the operation by the ligature of the main vessel, and I determined, if a case of long and steady bleeding should occur in my practice, I would not resort to ligature of the carotid artery, but would rely on the fainting of the patient for arrest of the hæmorrhage.[1]

[1] It is now many years ago since I had the opportunity of putting this intention into effect. In the Out-patient Department of St. Bartholomew's Hospital, a young and strong countryman, a little over twenty years of age, presented himself for removal of the tonsils. They were excellently well suited for removal with the guillotine, and I took the opportunity of demonstrating the operation to my class of students. The operation was very easy, the tonsils were removed at their constricted necks, and the man was placed in an adjoining room under the charge of

In the one typical case in which I had the opportunity of putting this opinion to the test, the result fully justified my expectation. But, as a great deal of blood may be lost before the hæmorrhage ceases spontaneously, I think it would be better, in those cases in which the bleeding seems likely to continue for a considerable time, to fill the cavity with gauze and fix the gauze firmly in place by sutures passed through the arches of the palate.

During the last ten years I have very seldom been asked to remove tonsils which are easy to remove. Of course, I have removed large numbers of them in conjunction with adenoids. But almost the only tonsils not associated with adenoids which have been brought to me have been more or less difficult to remove, either on account of adherence of the tonsils, or because they presented some peculiar features, or because an attempt to remove them with the guillotine had failed, or on account of the condition of the patient. In all these cases, it is advisable to employ a general anæsthetic, and to separate the tonsil from its surroundings, when it can usually be readily removed with the guillotine.

By shelling out the tonsils. In some of the cases just mentioned, the removal of the tonsils can be far better accomplished by shelling the tonsils out of their beds. I do not know to whom we are indebted for the discovery of this method, nor can I remember where I first read an account of it. It read well, and I quickly put it in practice, and have frequently performed it during the course of the last ten or fifteen years. It is particularly indicated in certain cases: those in which repeated quinsies occur and, between the attacks, the tonsils are small and sunken, so that they cannot otherwise be satisfactorily removed; those in which there is reason to suspect the presence of

a dresser. In the course of half an hour, during which I was busy with other patients, the dresser came to tell me that the patient had not ceased to bleed. I found that blood was running, or, rather, very rapidly dripping, from the wounds, so that a porringer was filled with blood in the course of some minutes. Applications of hot water and ice-cold water, of gallic and tannic acids, of pressure in various forms, seemed to increase rather than diminish the steady flow of blood. I ordered the man to be taken into one of the surgical wards and put to bed, but the bleeding still continued. There seemed to be no great change in the pace, sometimes slower, sometimes a little quicker, but never showing any sign of arrest. Shortly afterwards I had to leave the hospital on an urgent call. The house-surgeon was very anxious to have my authority to tie the common carotid artery if it should seem to him to be required; but I declined to give the authority, and told him that I was certain the hæmorrhage would cease spontaneously as soon as the patient became faint. And this is what actually happened. The wounds continued to bleed for about four hours, when the patient became suddenly faint and the hæmorrhage ceased. Nor did it recur, and he recovered as well as any other patient could have done.

tubercle and it is desirable to remove the entire tonsil; those in which the tonsils quickly grow again after removal with the guillotine; those in which a malignant growth, which is not fitted for radical operation on account of inoperable affection of the glands, is limited to the tonsil, and the removal of the primary disease is desirable for palliative reasons; and a few cases in which the follicles of the tonsils are constantly exuding offensive material, and are so deep and sinuous that they cannot well be destroyed by the electric cautery. The operation is not at all difficult. It is performed as follows :—

A general anæsthetic is administered and the mouth is kept open by a strong gag, such as Coleman's gag. The patient is laid on one side with only a very thin pillow for the head. The tonsil next to the operating-table is dealt with. An incision is made through the mucous membrane above its upper border with a blunt-pointed pair of scissors. The forefinger is introduced into the incision, and the tonsil is separated from its bed from above downwards, and from side to side. The mucous membrane at the sides is torn through with the finger until the tonsil hangs in the throat by the membrane attached to its lower border. The tongue is now depressed, the tonsil seized with forceps and drawn forward, and the membranous attachment is cut through with the scissors. Or it may be cut off with the guillotine. The patient is now turned over on the other side and the second tonsil is dealt with in the same manner. In most cases the tonsil is separated from its bed with surprising ease; but it sometimes happens that it has become firmly adherent, owing to repeated attacks of inflammation, so that considerable difficulty may be experienced in separating it. In such cases the operator must be cautious and avoid too rough usage. An occasional snip with the scissors is often safer than a forcible attempt to unseat the tonsil with the finger. The hæmorrhage which follows the operation is a little more severe than that which occurs after tonsillotomy, unless the tonsil is very easily separated, but it quickly ceases, and I have only known one case in which it occurred at a later period (the same night), when again it ceased spontaneously, and the patient made a good recovery. Convalescence is usually a little longer than after tonsillotomy.

Removal of inflamed tonsils. In the very rare instances in which it has been deemed advisable to remove tonsils which are actually in a condition of inflammation—for example, in one or two instances in which continued illness was thought to depend on the presence and continuance of a condition of chronic inflammation of the tonsils—I have preferred to shell them out, both on account of the desirability of removing the whole of the tonsils, and in the expectation that there would be less bleeding

from the operation. These patients recovered from the operation almost as speedily as other patients.

The removal of the tonsils of patients suffering from constitutional syphilis. More than once I have had patients sent to me for removal of the tonsils who were suffering from secondary syphilis, and, naturally, I have advised against the operation ; but it has happened to me to perform it on two occasions. Many years ago a young married woman, who was a patient in the Throat Department, presented a condition of the tonsils which was very unusual, but which did not suggest secondary syphilis. The tonsils were much enlarged, prominent, not inflamed, and blotched with yellow areas around the follicles. After she had attended two or three weeks, I guillotined the tonsils. In the course of a fortnight she came back to the hospital with typical secondary syphilis of the throat and mouth. Some twelve or more years ago, I operated on a young gentleman about twenty years of age for the removal of adenoids and tonsils which had been neglected. The anæsthetic was not very well administered, and I received a severe pinch from the teeth of the patient, but, by good hap, the skin was not broken. Ten days later his medical attendant brought him to my house and told me that he was not healing so fast as he ought to do. On examination he had typical secondary syphilis of the throat and mouth, and it was then discovered that he had recently suffered from a primary sore on the penis. Mercury was administered to both patients, and both made good recoveries. In such cases, the danger appears to be greater to the operator than to the patient.

REMOVAL OF TUMOURS OF THE TONSIL

Innocent. I do not remember to have seen any other innocent new-growths of the tonsil than papillomata. If they are snipped off with scissors, the base must be destroyed with the galvano-cautery, otherwise the tumour will recur. If the papilloma has a large attachment and the tonsil be enlarged, it is better to remove the tonsil.

Malignant. Malignant disease of the tonsil occurs in two quite different varieties : squamous-celled carcinoma, and round-celled sarcoma, often called lympho-sarcoma. From the operative point of view, the chief difference between the two diseases is in the bulk of the primary tumour. For whereas the lymphatic glands are liable to be affected by both varieties, and the distribution of the lymphatic gland disease is similar for both, epithelioma of the tonsil frequently presents itself as a flat ulcerated growth, while sarcoma often forms a mass of considerable size, which may be free from ulceration. The greater liability of the internal organs to metastasis in the case of sarcoma does not affect the

question of operation on the primary disease and glands, except in so far as there may be reason, in a particular instance, to fear that secondary disease may be already present.

The aim of the surgeon must be, in every case, to remove the primary disease in such a manner that it shall not recur, and to make a free removal of the glands in the neck. How far it is possible to attain this aim must, however, depend on the conditions of the individual case. It may be laid down as a general rule that large operations which involve the removal of the contents of the anterior triangle, and perhaps of the posterior triangle, together with the disease within the mouth, at a single sitting, are attended with very much greater danger than the removal of the internal disease and of the glands at two separate sittings. If, therefore, it be consistent with the condition of the parts to divide the operation, this should certainly be done. If the primary disease be squamous-celled carcinoma, and of small extent and confined to the tonsil, it may be dealt with through the mouth. If, on the other hand, it be sarcomatous and involves the entire tonsil, the prospect of local recurrence is so much greater that it is doubtful whether sufficiently wide removal can be effected through the mouth.

Operation. Various methods and instruments have been recommended for the operation through the mouth. For my own part, I have always been in the habit of removing growths limited to the tonsil, and not fixed to the deeper parts, by shelling out the tonsil, after the manner which has been already described. Much greater care must certainly be taken in separating the tonsil at the sides, and scissors should be used to determine more accurately than the finger can do the limits of the operation. Care must be taken not to tear through the disease, and for this reason, if for no other, the mucous membrane attachment at the lower margin of the tonsil must be cut rather than torn through. The hæmorrhage is not greater in shelling out a tonsil with malignant disease upon its surface than it is in shelling out a tonsil which is the subject of ordinary enlargement. Preliminary laryngotomy is, therefore, seldom necessary, although the operator may feel less anxious if he has performed it. Severe hæmorrhage and considerable difficulty in separating the tonsil from its bed may generally be taken as a proof that the depth and extent of the disease have been underestimated, and that the case was not suitable for the operation. Such an error need not prove fatal to the patient immediately, but it may seriously impair the prospect of a larger operation a few days later. The operator should therefore be as sure as he can be that the disease is not fixed to its bed and that it does not affect the half-arches of the palate.

A few days after the tonsil has been shelled out, the contents of the

anterior triangle can be removed. The incisions are the same as for the typical removal of the contents of the anterior triangle (see p. 229). With regard to the extent and scope of this operation, it may be said generally that the glands in the superior carotid (parotid) region are those which are liable to be first attacked, while the submental gland and even the submaxillary lymphatic glands are less liable to disease than they are in relation to cancer of the tongue. On the other hand, the glands beneath and behind the sterno-mastoid muscle are more liable to disease. If the parotid group of glands be badly affected, the operation should be extended to the division of the sterno-mastoid muscle, the turning up and down of the two halves, and the complete clearance of the tissues which contain the lymphatic glands beneath and behind the line of the muscle. After the structures have been removed, the two halves of the muscle should be joined together by stout catgut sutures, prepared to last for twenty days. If the primary disease appears to be too fixed to be shelled out, it may still be widely and deeply excised from the mouth after preliminary laryngotomy and splitting the cheek back to the masseter muscle. This modification affords very good access to the seat of the disease. But when the primary disease involves the neighbouring structures and is firmly fixed to its bed, and yet appears within reach of an extensive and dangerous operation, the cervical glands should be removed at the first sitting, and the external carotid and its branches tied and removed. The internal disease may be removed, with or without division of the lower jaw, at the same sitting, if there be urgent reason for completing the operation at a single sitting. It is preferable to defer it, if possible, until the external wound is healed. It can then be reached through the mouth after the cheek has been split, or through the opposite side of the neck in the manner described for removal of the base of the tongue.

After-treatment. The after-treatment of these large operations on the tonsil should be carried out on similar lines to the after-treatment of large operations on the base of the tongue and pharynx. The wound should be plugged with gauze; the laryngotomy tube may with advantage be retained for a few days; the feeding may be carried on through a tube which is passed at each meal; and the posture of the patient should be that which has been recommended after the larger operations on the tongue and pharynx.

Results. The final results of operations for malignant disease of the tonsil are not good. Indeed, some years ago, they were so bad that it seemed scarcely worth while to perform them. The tendency of sarcoma to early and extensive metastasis renders the prognosis very unfavourable. The best results are to be expected in the case of epithelioma of limited extent when the primary disease and the glands have been widely removed.

CHAPTER III

OPERATIONS UPON THE PHARYNX

OPERATIONS FOR RETROPHARYNGEAL ABSCESS

Acute septic suppuration behind the pharynx is often a very formidable disease, and the collection of matter may attain a considerable size and be associated with high fever. In such cases the surgeon is sometimes tempted to open the abscess through the mouth, but this should only be practised in those cases in which the abscess is of small size and the general symptoms are trivial. For, in addition to the danger of letting loose a large quantity of pus at the back of the throat, some of which may be sucked down into the air-passages, the pus is often exceedingly offensive and dangerous owing to its septic qualities. In these cases, the abscess should be opened through the side of the neck, where bulging may often be distinguished, or, at least, sufficient deep-seated swelling to guide the operator. No general directions are needed for the operation beyond those which would suggest themselves to a prudent surgeon: to make a sufficient external incision, to avoid the large vessels and nerves, to use a sharp-pointed director in place of a knife after the skin and cervical fascia have been divided, and to dilate the opening with forceps. When the pus has been evacuated, the cavity should be treated in the same manner as abscess cavities of a like kind are treated in other parts of the body: it should be drained to the bottom and frequently cleansed with antiseptic solutions.

Chronic abscess occurs generally in children, and is, probably, almost always of tuberculous origin. It also may attain so considerable a size as to interfere with swallowing and respiration. In such cases, it may be necessary to open the abscess through the side of the neck. But, if it be small or only of moderate size, it may be safely opened through the mouth, and chloroform may be needed for the purpose. The child is held, if it be quite young, in the arms of a nurse, the head is held back, the tongue is depressed so that the tumour can be plainly seen, a free incision is made into it from below upwards, and the child is turned well over on one side or on its face with the head forwards, so that the pus runs quickly out of the mouth. Anæsthesia should be as light as the proper opening of the abscess will permit.

OPERATIONS FOR TUMOURS OF THE PHARYNX

Innocent. I only remember to have performed one operation for the removal of a tumour of some size which was not malignant, and that tumour lay behind the posterior wall of the pharynx. It was lobed, quite circumscribed, and not adherent, either to the parts behind or to the wall of the pharynx. The operation was performed through the mouth by an incision along the front of the tumour. When it was sufficiently exposed it was shelled out with the finger. But when I came to examine the pharynx in the course of the first days after the operation, it soon became apparent that a portion of the growth had been left behind. The operation was therefore repeated, and the remainder of the tumour was extracted. The patient was well several years after the operation.

This operation was performed many years ago, and was not attended with serious hæmorrhage. But it might have been performed much better and with greater safety to the patient had it been preceded by laryngotomy.

Malignant. I have had very few cases under my care in which the disease has been limited to the pharynx. It has almost always involved the tonsillar region or the larynx, or even reached to the base of the tongue. Further, the lower margin of the disease has generally been out of sight, below the back of the larynx. It has therefore been very difficult to determine before operation whether the growth was within reach of a radical operation limited to the posterior wall of the pharynx.[1]

Few operators care to attack a growth which extends completely around the lower part of the pharynx on account of the closure of the canal which arises as the result of removal, yet Gluck has obtained some remarkable successes.

There seems to be no reason why a small epithelioma limited to the posterior wall of the pharynx and completely in view through the mouth should not be removed through the mouth after the performance of laryngotomy. It should be possible to cut it out as widely and as deeply as an epithelioma of many other parts of the body. But I have had no experience of such cases.

Operation. The operation I have practised for the more widely extended growths has been through the side of the neck. The incisions and early steps differ so little from those required for the removal of the

[1] I have not yet had an opportunity of testing Hald's method of hypo-pharyngoscopy, which would perhaps enable the operator to judge better of the extent of the disease and of the propriety of attempting to remove it. These points can, I hope, be determined by examination with the later constructions of œsophagoscope.

base of the tongue (see p. 224) that it is not necessary to repeat them here. Provided the operator has definitely determined to remove the disease, it is well to remove the contents of the anterior triangle first, and to remove at the same time the external carotid artery and its branches. The external carotid artery on the opposite side of the neck may be dealt with also. The operation in the mouth is, by this means, rendered far more easy, and the greatly diminished hæmorrhage permits it to be performed much more thoroughly and satisfactorily. For reasons which have already been discussed (see p. 225), it will generally be better to expose the disease from the opposite side of the neck.

A preliminary laryngotomy should be practised, and a sponge placed at the bottom of the throat until such time as the upper margin of the larynx is accessible through the opening in the side wall of the pharynx, when a small sponge may be thrust into the upper part of the larynx in substitution for the sponge in the bottom of the pharynx. The precise situation and extent of the disease are now determined, together with its possible relation to the larynx, and the operator must decide whether to remove the larynx or any part of it. I believe it is useless to attempt to save the larynx if it is involved, even if the involvement be limited apparently to the upper part on one side. In more than one such case I have cut away a considerable portion of the larynx, but the disease has recurred in the larynx, so that I now despair of a successful result with the saving of the larynx. The extent and depth of the operation, otherwise, depend on the situation and depth of the disease, and no rule can, as yet, be laid down beyond the general rule, to remove *far beyond* the apparent margin of the cancer, and to remove the structures beneath it until the flat surface of healthy muscle has been reached. In all these operations, the greatest care must be exercised to remove the disease in one piece, and not to cut through it or tear it in the course of removal, for fear of infecting the wound with cancer in the course of the operation. If this accident should unfortunately happen, the surface of the wound should be liberally swabbed with pure carbolic acid.

After the growth has been removed, the bleeding veins should be tied with catgut or No. 00 silk, and the cut edges of the mucous membrane, particularly the lower and posterior edges, should be fastened to the subjacent structures with catgut sutures. Discharge is thus less likely to soak down between the mucous membrane and the subjacent structures; and if the feeding-tube should happen to be coughed or choked up during the first few days after the operation, the introduction of another tube is not likely to be so difficult or dangerous as it is when the cut edge of the mucous membrane hangs detached from the parts beneath. A soft

india-rubber tube should be introduced into the œsophagus at the end of the operation, and retained for the purpose of feeding. The end of the tube should be brought out through the mouth, not through the wound in the neck. In the cases in which I have brought it out through the side of the neck, I have generally regretted having done so, as it interferes with the rapid closure of the external wound, a matter of considerable importance in those cases in which both the external carotid arteries have been tied. The cavity from which the disease has been removed should be packed with gauze, which may need to be kept in place by a few catgut sutures. The gauze may be removed in from one to three days after the operation and replaced each day after the cleansing of the wound. During the first two or three days it is well to retain the laryngotomy tube: the patient is safer and more comfortable than without it.

After-treatment. After the operation, when the patient is replaced in bed and sufficiently recovered from the anæsthetic, he lies on his side with the head low, generally on the side from which the disease has been removed, so that the wound of approach through the neck is kept free from decomposing discharges and has the better chance of closing by the first intention. During the first days antiseptic washes and sprays are used, and occasionally iodoform powder is blown into the cavity, while care is taken to clear away the discharge as it collects.

If the feeding-tube is, from any reason, displaced, it may be almost impossible to replace it unless with the aid of a general anæsthetic. In such circumstances, it is often easier to introduce the tube on a fine whalebone guide. The guide should be bulb-pointed, with a slender neck above the bulb, which will admit of ready bending of the whalebone at that point. The utmost care should be exercised not to thrust it through the soft mucous membrane or between the membrane and the subjacent structures. It should not be passed down unless it runs quite smoothly and without resistance. Ten days or a fortnight may elapse before the feeding-tube can be dispensed with.

Even old and feeble patients will recover from these operations, and the only people whom I regard with disfavour are those who are suffering from serious organic disease or whose tissues are soaked with alcohol. Of the habitual alcoholics, I regard with most suspicion men from forty to fifty years of age. They are liable to fall to pieces with great rapidity after extensive operations which involve large open wounds. Free livers from sixty to seventy years of age, or even older, are not nearly such bad subjects. They are seasoned vessels, whose very age is a proof of the strength of constitutions which have been tried by years of never-ceasing incontinence in regard to stimulants.

Results. Of the final results of these large operations, I have no better tale to tell than that which may be told by any surgeon of the same experience—an occasional case of success and a large number of cases in which the disease has rapidly recurred.

I would only add that, if the disease has decidedly involved the larynx, so that the operator has determined, before the commencement of the operation, that the larynx must almost certainly be removed, Gluck's incisions and proceeding from the front will probably be more suitable than the operation from the side.

SECTION III

OPERATIONS UPON THE TONGUE TONSILS, PHARYNX, AND ŒSOPHAGUS

PART II

OPERATIONS UPON THE ŒSOPHAGUS

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CHAPTER IV

OPERATIONS UPON THE ŒSOPHAGUS

EXCISION OF ŒSOPHAGEAL DIVERTICULA

ŒSOPHAGEAL diverticula most commonly occur immediately below the level of the cricoid, at the junction of the pharynx with the œsophagus. They project from the posterior aspect of the œsophageal tube on the left side, and vary in length from a mere depression to a definite narrow-necked pouch several inches long. The lumen of the œsophagus is usually unaltered at the level of the pouch, though a definite constriction may be met with immediately below its orifice: a good example of this is reported and depicted by Richardson (*Ann. of Surg.*, May, 1900, p. 529). Halstead (*Ann. of Surg.*, 1904, vol. i, p. 192) has recorded a case in which the lower border of the neck of the diverticulum formed a valve-like projection into the lumen of the œsophagus, demonstrating one method by which obstruction to the natural passage is produced.



FIG. 108. INCISIONS FOR OPERATIONS UPON ŒSOPHAGUS IN THE NECK. A, Guattani's; B, Kocher's.

Examination with the X-rays is sometimes a useful preliminary to operation, as in a case of Landauer's (*Centralb. f. Inn. Med.*, April, 1899), where a photograph taken with leaden sounds passed into the pouch accurately indicated its situation. Or it may be possible after one or more doses of bismuth oxycarbonate to distend the pouch so that an X-ray photograph may be obtained.

Many cases have now been recorded of successful operations for this condition. Richardson (*loc. supra cit.*, p. 525) collected 56 cases,

of which 18 had been dealt with by operation, viz. 16 by excision and 2 by Girard's method. Butlin (*Brit. Med. Journ.*, 1903, vol. ii, p. 65) published a second series of 8 cases, making 12 in all, of which he had operated on 8, and it is to the latter, who was the first

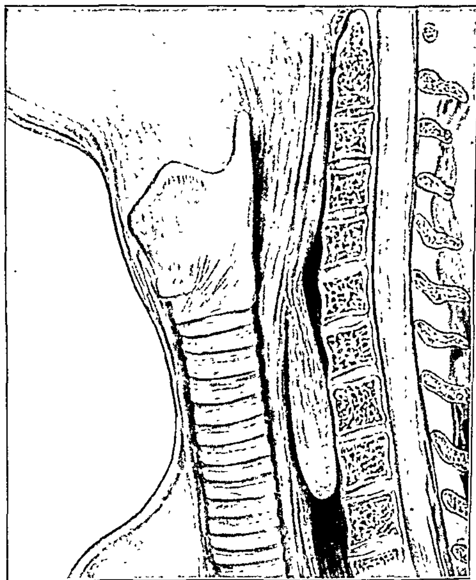


FIG. 109. AN ŒSOPHAGEAL DIVERTICULUM. This and the four following figures are from Prof. Richardson's paper in the *Annals of Surgery*.

surgeon in England to undertake operation for this condition, that we are indebted for much of our knowledge relating to the symptomatology and to the indications for operation.

Operation. The patient is placed under the influence of a general anæsthetic, chloroform preceded by a hypodermic injection of morphine

being the most suitable for such cases. A preliminary gastrostomy may then be carried out as recommended by Goldmann. An oblique incision is made along the anterior border of the left sterno-mastoid from the upper border of the thyreoid cartilage to the suprasternal notch (see Fig. 108, A). The deep cervical fascia is divided and the anterior jugular vein secured between ligatures, when the depressors of the hyoid bone are exposed. Of these the omo-hyoid is divided, while the sterno-hyoid

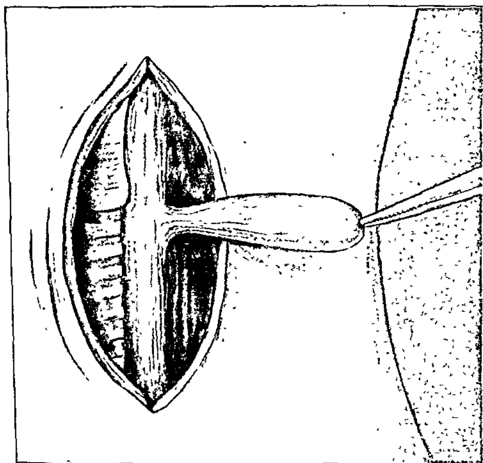


FIG. 110. EXCISION OF AN ŒSOPHAGEAL DIVERTICULUM. (Richardson, *Annals of Surgery.*)

and sterno-thyreoid are retracted, or, if necessary, cut through as recommended by von Bergmann (*Arch. f. Klin. Chir.*, 1892, vol. xliii, p. 1). At the upper end of the wound the branches of the superior thyreoid artery are ligatured, and the dissection is carried deeply on the outer side of the thyreoid gland, which with the larynx is both drawn inwards and rotated on its long axis to the right: the carotid vessels are carefully defined and drawn outwards with a large blunt retractor. At this stage of the operation help in the definition of the diverticulum will be

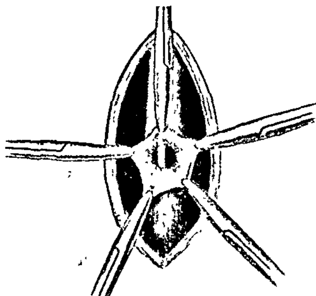


FIG. 111. REMOVAL OF THE DIVERTICULUM. The bougie is seen in the lumen of the œsophagus.

FIG. 112. SUTURE OF THE ŒSOPHAGUS AFTER EXCISION OF THE DIVERTICULUM. (Richardson, *Annals of Surgery*.)

obtained, as suggested by Butlin, by the passage of a curved pliable bougie into the diverticulum; also the œsophagus is defined, so as to avoid opening it inadvertently, by the passage of a long bougie from the mouth into the stomach.[1] Careful dissection should now expose the wall of the pouch lying to the left of the œsophageal tube, and traction upon it with forceps as it is separated from the other

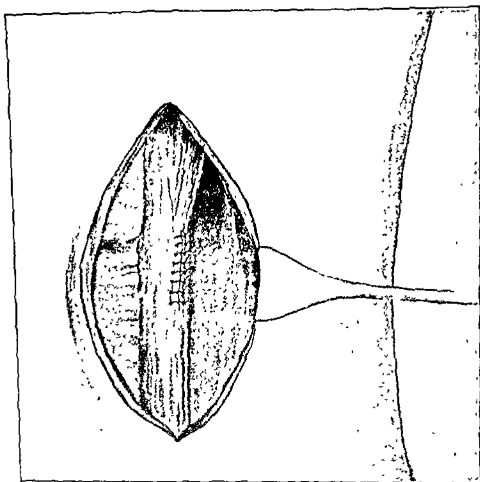


FIG. 113. EXCISION OF ŒSOPHAGEAL DIVERTICULUM. The operation completed. (Richardson, *Annals of Surgery.*)

tissues will enable the fundus to be drawn out of the wound, leaving the pouch connected with the œsophagus only by its neck. Butlin recommends that the pouch be now cut away at its neck from above downwards, and, as this is being done, the margins of the wound in the œsophagus be brought together by interrupted sutures. If these are inserted in a vertical row, so as to draw the lateral edges of the neck

[1] This may not be possible until the pouch has been freed and withdrawn from the wound, as the œsophagus is often pushed aside by a large distended diverticulum (Butlin).

of the pouch together, slight stenosis of the œsophagus at this level may result, so that when practicable it is better to cut gradually through the neck of the diverticulum transversely, and suture the upper to the lower margins of the incision, so as to form a transverse line of sutures upon the œsophageal wall.

In order to avoid opening the œsophagus and to eliminate the consequent risk of infecting the wound or of producing an œsophageal fistula, Girard of Berne twice invaginated the pouch into the œsophagus, and sutured the external aspect of its neck by three layers of sutures. This procedure was probably followed by atrophy of the pouch, as no obstruction resulted after these operations. Halstead (*loc. supra cit.*) treated a case by a somewhat similar method. The sac was isolated, and a purse-string suture of catgut was inserted around its neck. The sac was then invaginated into the œsophagus and the purse-string suture tightened. Over this three layers of sutures were inserted, the first two drawing together the longitudinal muscular layer of the œsophagus transversely, while the third layer, by which the lower fibres of the inferior constrictor were brought down so as to cover the œsophageal wound, was introduced at right angles to the first two layers of sutures. Halstead points out that this method is only adapted to diverticula of small size and to cases where the lumen of the œsophagus is not constricted at the level of the diverticulum. In cases where a constriction of the œsophagus is present immediately below the orifice of the diverticulum a more elaborate plastic operation may be necessary in order to overcome it. Richardson (*loc. supra cit.*) met with a case of this kind, and as he overcame the œsophageal stenosis by an ingenious plastic operation, a brief account in his own words may be here inserted:—

'The index-finger was passed carefully through the neck of the pouch into the œsophagus, and met with a constriction surrounded by friable mucous membrane. As this was done a longitudinal tear of this constricted portion resulted, and it was seen that the œsophagus below the opening had only the diameter of a lead pencil. The tear in the œsophagus was converted into a longitudinal slit by extending the incision downwards in the posterior wall through the lower border of the neck of the sac and through the constriction. The pouch was then cut off, leaving a considerable crescentic margin of its wall above the opening. The lower margins of this flap were then brought downwards and sutured together in the gap made by the divided posterior wall of the œsophagus, by which method the lumen of the œsophagus was slightly increased transversely. The subsequent effect of this plastic operation demonstrated its advantages, for afterwards the probang could be passed into the stomach without the least obstruction.'

Whatever method is adopted for suture of the œsophageal wall, there is great risk of leakage and infection of the cellular tissues of the neck, so that drainage should be provided in every case by the insertion either of a drainage tube or of gauze, packed right down to the external aspect of the œsophageal wound. The upper half of the wound in the neck may be closed with interrupted sutures, but the remainder of the wound must be left open for the purposes of drainage.[1] Butlin (*loc. supra cit.*), in dealing with this question, recommends that drainage with a soft tube should always be employed. He draws attention to the importance of opening up the cellular tissue of the neck as little as possible in the course of such an operation, owing to the risk of septic infection travelling downwards into the posterior mediastinum.

After-treatment. With regard to after-treatment, Butlin recommends that an œsophageal tube should be passed from the mouth into the stomach and retained for feeding purposes until the œsophageal wound is firmly closed. As a less desirable alternative a tube may be introduced into the stomach through the cervical wound, and retained until the wound is healing by granulation. Though in many of the recorded operations, as in Richardson's case quoted above, a temporary œsophageal fistula resulted, this eventually healed by granulation, and the patients are reported to have regained the power of normal deglutition without any evidences of constriction of the œsophagus at the site of the diverticulum.

CERVICAL ŒSOPHAGOTOMY

Indications. (i) For the removal of foreign bodies, usually large and irregular, such as tooth-plates, which have passed easily through the pharynx only to become impacted at or within a short distance of the upper end of the œsophagus. Killian (*Zeitschrift für Ohrenheilk.*, 1908, vol. l, p. 120) states that in his experience it is at this level that foreign bodies are usually retained, unless they are soft and smooth and glide easily. Should a foreign body pass the upper orifice of the œsophagus, it will probably readily traverse the mediastinal portion of the tube, which is easily dilatable, yet may become fixed within 2 inches of the cardiac orifice.

(ii) For the excision of benign œsophageal growths, *e.g.* polypi, when removal by the snare, aided by œsophagoscopy, is impossible.

[1] Cellulitis is less probable than after operation for foreign body when it is due to already existing infection (Richardson).

(iii) For the division of deeply situated fibrous structures of the œsophagus, which Güssenbauer has undertaken by this method.

(iv) For the suture and drainage of external wounds, stabs, and bullet wounds.

Œsophagoscopy, as introduced by Mikulicz, under cocaine in adults or a general anæsthetic in children, will enable a surmise as to the localization of an impacted foreign body founded on the symptoms and the position of pain to be confirmed, and through Killian's tube the large majority of smooth regular foreign bodies, *e.g.* coins, may be removed by long suitably curved forceps. This method of examination is, however, contra-indicated when severe pain in the neck, rise of temperature, and subcutaneous emphysema are present, suggesting that the foreign body has perforated the œsophageal wall; it is also inadvisable and may be impossible when secondary inflammation, possibly increased by ineffectual attempts at removal of the foreign body with a probang or coin-catcher, has extended to the larynx, causing dyspnœa which may urgently call for œsophagotomy.

Coins, tooth-plates, or any body partially composed of material opaque to X-rays may be localized in the œsophagus by radiography, and comparison of plates exposed at intervals of twenty-four hours will yield valuable evidence that the foreign body has either become impacted or is being steadily carried on towards the stomach. Gentle passage of a bougie will, when the aids to diagnosis mentioned above are not available, indicate at what level the foreign body is lodged, though on meeting with any obstruction the bougie must be at once withdrawn, as the use of force may cause a rigid sharp foreign body to penetrate the œsophageal wall.

Œsophagotomy is indicated for the removal of a foreign body which is seen by radiography or through Killian's tube to be large and irregular, as removal with forceps is likely to lacerate the œsophagus, when there will be great risk of cellulitis of the neck.

Œsophagotomy is imperative when symptoms of perforation of the œsophagus are present, *e.g.* intense pain at the seat of perforation, rise of temperature, and subcutaneous cervical emphysema; here, as pointed out above, the passage of Killian's tubes or forceps either for purposes of diagnosis or treatment is likely to make matters worse. Operation must be quickly undertaken, and the infected cellular tissues of the neck must be freely opened up, and if possible the point of perforation must be discovered. With this object in view it is best to leave the foreign body *in situ*, and to cut down upon it by an incision either on the right or left side as may seem most convenient after consideration of an X-ray photograph; in such cases suture of the œsophageal wall is inadvisable, and

the superficial wound must be packed with gauze and drained. The prognosis under such conditions is more favourable when the perforation is situated high up in the cervical part than when it is in the mediastinal portion.

Before operating it is well to make certain by a second X-ray examination that the foreign body is impacted, as it is remarkable that many irregular foreign bodies, such as tooth-plates, with sharp projections upon them, may pass through the entire alimentary canal without danger to the patient. Lediard (*Clin. Soc. Trans.*, vol. xviii, p. 297) conscientiously records a case in which œsophagotomy was performed for a tooth-plate thought to be impacted below the thyreoid cartilage. An œsophageal tube was passed into the stomach, which was thought to impinge upon the plate as it was withdrawn. As the patient was still unable to swallow water, cervical œsophagotomy was performed, and a bougie was passed from the wound into the stomach. When this was done the operator 'believed that the plate was felt near the cardiac orifice of the stomach, but without giving the impression that the plate had been pushed into the stomach'. The plate appeared at the anus nineteen days from the date of impaction.

Similarly in the writer's practice examination of a five months' old baby detected a safety-pin brooch just below the level of the cricoid. Extraction with forceps was impossible, but a later examination with the X-rays showed that the brooch had passed into the stomach, and a week later the brooch, widely open, was passed without injury to the child.

At the same time all writers upon this subject have insisted that œsophagotomy, to give good results, must be promptly undertaken when other means of extraction have failed. The conclusion arrived at by Dr. Church (*St. Bartholomew's Hospital Reports*, vol. xix, p. 67), 'that there is very little risk in the operation itself, and that a good result may be fairly expected if the operation is done shortly after the foreign body becomes impacted,' still accurately defines the position.

Hæmorrhage, ulceration, and suppuration extending under the cervical fascia into the posterior mediastinum are likely to be early complications of impaction of a foreign body, and when septic infection of the tissues around the œsophagus has ensued, operation becomes a much greater matter.

Jacobson (*Operations of Surgery*, vol. i, p. 724), in discussing the question as to how low down in the œsophagus a foreign body can be extracted by cervical œsophagotomy, points out that the most accessible part is at its junction with the pharynx, opposite the cricoid cartilage,

and for the first two inches below this point. In his knowledge the lowest point from which a foreign body has been removed by cervical œsophagotomy occurred in the practice of Mr. Bennet May. Here a halfpenny, which had ulcerated through the œsophagus and opened the right bronchus, was removed successfully by œsophagotomy.

Fullerton (*Brit. Med. Journ.*, 1904) extracted by cervical œsophagotomy a halfpenny which was shown by the Röntgen rays to lie opposite the third and fourth thoracic vertebræ. At the operation it lay 4½ inches below the opening in the œsophagus, to which it was drawn up by a bent probe.

Richardson (*Lancet*, 1887, vol. ii, p. 707) contends that all portions of the œsophagus are in the cadaver accessible either from above or below, for he states that if the left fore and middle fingers are introduced through the cardia by means of a gastrotomy, and passed upwards into the œsophagus, they can be touched by the right forefinger introduced from above by a cervical œsophagotomy. Richardson points out that the lowest three inches of the œsophagus are just within the range of gastrotomy. He says that the right forefinger, introduced through the cervical wound, cannot reach quite so far on account of the sternum and clavicle. He therefore argues that, if the obstruction be less than 6 inches from the cricoid, an attempt may be made to remove it from above, but if the distance is more than this gastrotomy should be performed.

The writer's experiments on the cadaver do not at all coincide with Professor Richardson's conclusions, as in his experience at least two, and usually three, inches of the mid-thoracic portion of the œsophagus cannot be explored by the methods detailed above. And further, it is well to realize, as Richardson himself points out, that deductions drawn from the cadaver by no means hold good in dealing with the living subject.

Operation. The head is extended over a sand-bag placed under the lower cervical vertebræ, the face turned to the right, and an incision is made over the lowest part of the left anterior triangle. This may be either an oblique incision along the anterior border of the left sterno-mastoid, 4 inches long, terminating below at the upper border of the sternum (Guattani's incision) (see Fig. 114, A); or, as recommended by Kocher, a rather longer curved incision, convex downwards, so placed in the line of cleavage of the skin of the neck that it crosses the mid-line an inch above the sternum (see Fig. 114, B). The superficial fascia, platysma, and deep fascia are divided in the line of the skin incision, when the anterior jugular vein is divided between two catgut ligatures if necessary. The sterno-mastoid is drawn outwards, and the omo-hyoid being divided, the

sterno-hyoid and *sterno-thyreoid* muscles are retracted inwards. The pretracheal layer of deep cervical fascia, from which the capsule of the thyreoid gland is derived, must now be freely opened, the gland itself being drawn inwards, and the structures within the carotid sheath held as far outwards as possible by the same retractor that controls the sterno-mastoid. The lateral surface of the trachea is now defined, when the anterior surface of the œsophagus will be seen lying behind it, and projecting rather more to the left.

Difficulty in identifying the œsophagus may be overcome by the recognition of its red muscular wall or by distending it with a bougie introduced from the mouth. At this stage of the operation careful dissection with a Durham's elevator is necessary to isolate and avoid the recurrent laryngeal nerve and the inferior thyreoid artery, which pass upwards across the œsophagus from without inwards to lie in the groove between this structure and the trachea. These, after identification, may be drawn downwards and inwards, or *if unavoidable* the artery may be divided between ligatures.[1] Should the foreign body be impacted at this level, it can now be felt lying behind the cricoid or the upper rings of the trachea, and its location will determine the level of the incision to be made for its extraction: this must be vertical, and, if the foreign body be within the field of operation, should be *rather placed above than immediately over the foreign body*. When the latter cannot be felt, a longitudinal incision 2 inches long, placed as far back as possible upon the œsophageal wall, so as to avoid the recurrent laryngeal nerve, is made upon the end of the bougie which has been withdrawn, and so manipulated as to distend the œsophagus at this point.



FIG. 114. INCISIONS FOR OPERATIONS UPON ŒSOPHAGUS IN THE NECK. A, Guattani's; B, Kocher's.

Bleeding from the muscular tissue of the œsophagus, which is at

[1] It may be easier to dislodge the recurrent laryngeal nerve outwards, as in Mr. Lawson's case quoted below.

first free, is controlled by Spencer Wells's forceps, which serve as retractors to keep open the incision in its wall.

It will now usually be possible to remove the foreign body with long curved forceps if within three or four inches of the opening. But it is well to bear in mind that the very foreign bodies which defeat attempts at their removal through the mouth are, owing to their irregularities, often firmly impacted in the walls of the tube. The greatest care must be exercised in avoiding injury to the œsophageal wall, and when the foreign body is embedded at both ends in the mucosa it may require division with cutting forceps before it can be dislodged.

Mr. George Lawson (*Clin. Soc. Trans.*, vol. xviii, p. 292) records an instructive case of removal of a tooth-plate impacted in the œsophagus. Œsophagotomy was performed, but the plate was so firmly fixed into the wall of the œsophagus by the sharp clips which had retained it in the mouth that it required division with bone-forceps before its removal was possible.

When a clean incision has been made in the œsophagus, and there is no reason to suppose that its walls have been damaged by the foreign body or during its extraction, the margins of the wound should be brought together with interrupted catgut sutures, so passed as not to include its mucous lining. The deeper parts of the wound must now be carefully dried, and the cut surfaces of the omo-hyoid brought together. Sutures should also be inserted so as to bring together the fascial layers of the upper two thirds of the wound, the lower third being left open for a drainage tube passed right down to the surface of the œsophagus. This will occupy the lower angle of the skin incision, which otherwise should be brought together with sutures.

Difficulties. The chief of these are: a short neck in a fat subject; an enlarged thyreoid gland; cellulitis or suppuration already present. Firm impaction of the foreign body may increase the danger of laceration or perforation of the œsophagus, or the foreign body may be beyond the reach of the longest available forceps.

After-treatment. Rectal feeding is to be carried out for the first forty-eight hours, though sufficient water to allay thirst may be given by the mouth from the first. Should there be no tendency for fluids taken by the mouth to escape through the wound, enemata may be replaced by milk, meat juice, and other fluids given by the mouth, and at the end of the first week the patient may be allowed to take semi-solids. Kocher recommends that the patient be fed through a soft œsophageal tube passed from the wound and retained in position, and Lawson, quoted above, left his wound completely unsutured, and fed the patient for three weeks through an œsophageal tube. In discussing

the desirability of suturing the œsophagus he draws attention to the irritation of the wound which results from the constant flow of saliva over it, and which may, as in his case, produce some local cellulitis.

Dangers. The chief immediate danger is septic infection of the tissues of the neck owing to leakage from the œsophagus, sometimes resulting in mediastinitis or septicæmia. This may be best avoided by the establishment of drainage in all doubtful cases.

CERVICAL ŒSOPHAGOSTOMY

Indications. The establishment of a permanent opening into the œsophagus may be undertaken as a palliative operation for the relief of dysphagia due to obstruction from—

(i) An epitheliomatous growth at the junction of the œsophagus with the pharynx; or

(ii) Cicatricial stenosis, the result of syphilitic or traumatic ulceration at the same level.

At the present time this operation has fallen into disuse and has been replaced by gastrostomy, owing (1) to the greater difficulty of cervical œsophagostomy and the danger of injury to important structures, such as the recurrent laryngeal nerve; (2) the difficulty of making the artificial orifice so far below the growth that it may not become involved at a later date; (3) the constant discomfort to the patient from saliva flowing over the wound, and the risk of local infection of the cellular tissue from this source.

Operation. This is carried out exactly as has been detailed above in the performance of cervical œsophagotomy, but after the œsophagus has been opened its margins are secured to the edges of the skin wound with numerous interrupted sutures, or a rubber tube is inserted and the wound packed with gauze.

After-treatment. The after-treatment is similar, except that on the cessation of rectal alimentation fluids are passed into the stomach through a long œsophageal tube passed downwards from the wound.

CERVICAL ŒSOPHAGECTOMY

Indications. (i) This operation may be called for for the removal of a localized growth in the cervical portion of the œsophagus.

(ii) It may have to be undertaken as part of the operation of laryngectomy when a malignant growth primarily affecting the larynx has involved the œsophagus.

(iii) It has also been carried out when the œsophagus has been found involved in malignant tumours of the thyreoid gland.

In this article operation for cases of primary epithelioma of the œsophagus alone will be considered, and when the comparatively large number of conditions requiring partial œsophagectomy as part of a larger operation are excluded, it will be found to have a very narrow application. For clinically it is true that by the time that the cardinal symptom of œsophageal malignant disease, dysphagia, is so marked as to cause the patient to come for treatment the growth is so extensive that the whole lumen of the tube is usually involved for so considerable a distance that its radical removal is impossible.

Acting upon experiments made by Billroth on dogs, Kapper made two unsuccessful attempts to carry out the operation in 1875–6, but it was not until 1887 that the operation was successfully performed, when Czerny removed 6 centimetres of the whole circumference of the œsophagus for carcinoma.

Operation. The cervical portion of the œsophagus is exposed by the same method as has been detailed for œsophagotomy (see Fig. 114), but it will often be necessary to divide the left sterno-hyoid and sterno-thyreoid muscles, as well as the omo-hyoid. When the œsophagus is reached, its posterior aspect is freely detached from the prevertebral structures with a blunt dissector, after which it will usually be possible to locate the growth and to define its limits; if, however, this cannot be done, it may be necessary to open the œsophagus for this purpose. Careful dissection is necessary to separate the trachea from the anterior œsophageal wall, and in doing this great caution must be exercised, so as to avoid injury to the recurrent laryngeal nerves on both sides. When the whole circumference of the œsophagus has been isolated, it is cut through at least half an inch below the growth, and when there is any doubt as to the exact level to which it is involved it will be wise to sacrifice additional tissue in order to render recurrence less probable, even though by doing so greater difficulty will be experienced in carrying out the later stages of the operation. The whole circumference of the œsophagus is now isolated and the ring-like portion occupied by the growth removed by dividing the œsophagus well above and below the growth.

If the œsophagus has, as is always desirable, been divided so wide of the growth that recurrence is unlikely, it is almost always impossible to restore the œsophageal channel, and therefore it is often necessary to bring the cut ends to the surface. Great difficulty may be experienced in suturing the lower end to the skin, both on account of its shortness and of the fact that the sutures are not well held by the œsophageal wall. Butlin (*Operative Surgery of Malignant Disease*, p. 223) points out that even when this can be done stenosis of the œsophageal fistulous opening is extremely likely; whereas when the œsophagus cannot be drawn to the

level of the skin stenosis is inevitable. Kocher suggests the employment of a rubber tube, retained in position during the cicatrization of the wound, but even this is unlikely to prevent stenosis.

Results. De Quervain, in 1899, collected fourteen cases in which portions of the œsophagus had been removed, and though several of these were complicated by implication of adjacent important structures, such as the pharynx, larynx, thyreoid gland, &c., the immediate mortality from hæmorrhage, shock, posterior mediastinitis, and septic pneumonia in five cases shows that the immediate risks are excessively grave. In addition to this, recurrence rapidly followed in six of the other cases, and none of these survived the operation more than thirteen months. Further, it must be remembered that the patient's life, even if prolonged for a few months by such an operation, is one of considerable discomfort, owing to the extreme probability of stenosis of the œsophageal opening in the neck, which must render the life of the patient one of great misery. Difficulty may also arise in connexion with the upper end of the œsophagus, where a salivary fistula is likely to form, which, as in a case reported by de Quervain, tends to close and to cause infection of the cellular tissues, so that repeated dilatation with bougies may be necessary for this also.

TRANS-MEDIASTINAL OPERATIONS UPON THE ŒSOPHAGUS

ŒSOPHAGOTOMY

Indications. The indications for œsophagotomy are:—

(i) The presence of a foreign body so fixed within the thoracic portion of the œsophagus that it cannot be removed through Killian's tube, and at such a level that it cannot be reached *either from above by* cervical œsophagotomy or from below by gastrotomy.

The exact localization of an impacted foreign body or of a malignant stricture within this tube is now more definite, owing to the increasing use of Killian's method of œsophagoscopy, and in many cases of foreign bodies help may be obtained by means of an X-ray photograph.

If Richardson's deductions (see p. 276) from his experiments on the cadaver are correct, it is clear that mediastinal œsophagotomy for the removal of foreign bodies has very little place in surgery, as the dangers and difficulties of this operation far outweigh those of cervical œsophagotomy or of gastrotomy. But it seems probable that mediastinal œsophagotomy would be necessary for the removal of a foreign body impacted between a point 4 inches below the cricoid and a point 2½ inches above the cardiac orifice, that is, more than 10 and less than 12½ inches from the teeth. It is fortunate that this, the least accessible portion of the œsophagus,

corresponding to the bodies of the fourth, fifth, and sixth dorsal vertebræ, is very rarely indeed the site of impaction of a foreign body, for, as pointed out above, if it passes the narrow portion of the tube opposite the cricoid it will usually pass freely down to the level of the diaphragm.

(ii) The removal of a benign œsophageal growth, *e.g.* polypus.

The steps of the operation are those of the first stages of œsophagectomy (*vide infra*).

ŒSOPHAGECTOMY

Indications. This operation may rarely be required for the removal of œsophageal epithelioma, and has been carried out by this route by Rehn and others: hitherto no successful case has been recorded, but it is well to reserve judgment on the value of these procedures, as the surgery of the mediastina is still in its infancy.

The technique of these operations was first described by Nasiloff in 1880, and his method was adopted by Quénu and Hartmann in 1891. Nasiloff suggests that the upper part of the œsophagus is more easily reached on the left side, but on the right in the lower part of its course; while Potarca, after carefully studying the technique, advocated operation upon the right side only because of the danger and difficulty of dealing with the aorta on the left, though the way in which the right pleura naturally dips behind the œsophagus makes damage of this structure more likely when an operation is carried out on the right side. Rehn, in performing this operation on the living subject, followed Potarca's route through the right thoracic wall. Bryant (*Trans. of Amer. Surg. Assoc.*, 1895) states that the œsophagus should only be attacked on the left side above the aortic arch; below this point he exposes it on the right, and considers that below the ninth dorsal vertebra it is not accessible to surgical interference.

Clinical experience has shown that cases of œsophageal malignant growth which can be dealt with radically by excision of the growth very rarely occur. Sauerbruch (*Verhandl. d. Deutsch. Ges. f. Chir.*, 1905, vol. xxxiv, p. 140), after experimental operations upon dogs, is of opinion that the anatomical conditions in man are more favourable than in these animals. The results of operation would also be influenced by the nature of the obstruction, especially if it were carcinomatous. Statistics usually divide œsophageal carcinoma into that of the upper, median, and lower third of the œsophagus. From an investigation of 17,000 post-mortem inspections at Breslau, he found that during twenty-two years 204 were carcinoma of the œsophagus, 26 being in the cervical portion, and 163 in the thoracic portion, exclusive of the cardia. Of the latter, 117 were between the hilus of the lung and the cardia, 3 involved the entire œso-

phagus, and in 12 the site was not stated. Thus, out of 192 cases of carcinoma, 117, that is to say 60 %, were favourable for operation, at least so far as position was concerned, and 70, that is 36 %, were absolutely favourable, as Sauerbruch's invagination operation was possible. The results are naturally influenced by the general condition of the patient, and above all by the presence of adhesions or metastases. He points out, however, that pathological anatomy and statistics indicate that metastases occur comparatively late in œsophageal carcinoma, but when they do occur are very numerous and affect the posterior mediastinal glands, so that operative interference is of very little use.

Operation. The patient is anæsthetized, and placed in the semi-prone position on the left side. A longitudinal incision 8 inches long is made midway between the spines of the vertebræ and the inner border of the right scapula (see Fig. 115). This is carried down to the ribs, and a rectangular flap, fashioned by carrying horizontal incisions from the two ends of the vertical incision inwards to the mid-line, is reflected inwards. The exposed ribs are resected subperiosteally within the limits of the wound, 2 to 3 inches being removed from each. Heidenhain points out that easier access to the posterior mediastinum may be obtained by resecting the transverse processes of the corresponding vertebrae, and completely removing the posterior portion of the ribs from the heads outwards. Kocher considers that it is usually necessary to resect more than four ribs, the second to the seventh or the fourth to the ninth according to the situation of the disease, and advises that 4 inches of these ribs be resected subperiosteally.

Sauerbruch ('Die Chirurgie des Brustteils der Speiseröhre,' *Beiträge zur klinischen Chirurgie*, 1905, vol. xlvi, p. 405) recommends as an alternative a long intercostal incision, as giving adequate room and avoiding severe hæmorrhage and damage to nerves and muscles: its chief disadvantage would appear to be that it entails manipulation of the deeply seated œsophagus through a narrow wound; this may be partly avoided by the use of Mikulicz's rib-retractor.

After dividing the intercostal muscles the intercostal vessels and nerves must be defined, and the former divided between ligatures. The parietal pleura should now be freely exposed, and its attachments over the heads of the ribs and upon the lateral surfaces of the vertebræ carefully separated outwards with the finger or with a blunt instrument. In doing this it must be remembered that the sympathetic chain passes down over the heads of the ribs, and great care must be taken to avoid this structure.

As the posterior surface of the œsophagus is exposed, the vena azygos major, with the right vagus, comes into view, and the latter must be pulled

aside and the vein ligatured. The œsophagus, unless adherent to surrounding structures, can now by further careful dissection be drawn into the wound, and if the operation has been undertaken for the removal of a foreign body it should now be possible to locate it. For the purpose of its removal the œsophageal wall is incised, and the foreign body removed; in doing this branches of the vagi must be carefully avoided. If it be necessary to excise a portion of the œsophageal wall for the removal

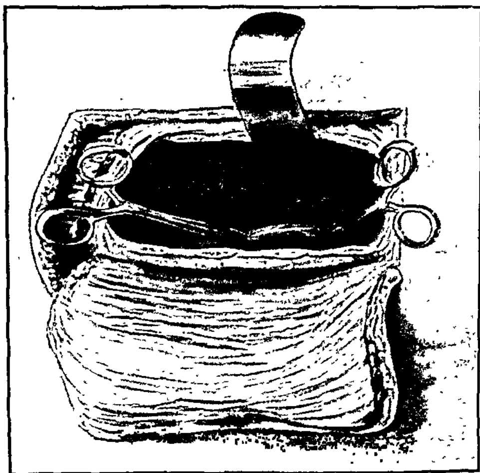


Fig. 115. Trans-mediastinal Œsophagectomy. Parts of seventh, eighth, ninth, and tenth right ribs resected; œsophagus pulled up with Spencer Wells's forceps.

of a malignant tumour, this may now be done, when both ends of the œsophagus must be drawn into the wound, and drained by means of rubber tubes carefully sutured in position. The lower end of the œsophagus may be used for feeding purposes, and for this a long œsophageal tube should be passed through it down into the stomach. Or if, owing to its depth from the surface of the thoracic wall, this be considered impracticable, gastrostomy should be undertaken.

Mikulicz (*Deutsch. Med. Wochenschrift*, April 14, 1904) drew attention

to the difficulty of reuniting the two ends after resection in the following words: 'The straight muscular tube which we call the œsophagus is but little stretchable; hence, even simple division and reuniting of the cut ends is not easily accomplished, as the œsophagus is slightly shortened thereby, and the consequent tension is apt to cause the divided ends to retract. In resections, of course, this difficulty is far greater.'

He pointed out that resection of the lower portion is far easier than resection of the upper portion of the œsophagus, for the reason that in the former the cardiac portion, as well as the fundus of the stomach, can be drawn up through the enlarged orifice in the diaphragm sufficiently to allow it to be sutured to the upper part of the tube so as to make up for the defect caused by the resection. Again, different operations are required in his opinion for resections in these positions, for in resection of the upper thoracic portion of the œsophagus he recommends posterior thoracotomy in the third to the fifth intercostal spaces. Here the tube is exposed behind the hilum of the lung, and the vena azygos major, which crosses the œsophagus at this level, must be pushed aside or may require to be doubly ligatured after division.

Although it is feasible to stretch the two ends of the resected œsophagus so as to perform an anastomosis, it was, in his opinion, doubtful whether the sutures would hold on account of tension. Mikulicz, therefore, no longer attempted to reunite the œsophagus after high resections, but closed the gastric end and dropped it back into the wound, and the patient was fed by means of a gastrostomy previously carried out. The pharyngeal end of the œsophagus was pulled out through an incision made along the anterior border of the left sterno-mastoid, which, as he stated, is easily done because it is only loosely held by connective tissue at this level; the wounds in the thorax and neck were now closed, and the upper end of the œsophagus was drawn downwards under a bridge of skin and fixed to a new incision over the second intercostal space after the manner of a Frank's gastrostomy: von Mikulicz intended to unite this latter to the stomach so that mouth-feeding might be again possible. For resection of a growth in the lower end of the œsophagus anterior intercostal thoracotomy in the fifth or sixth space was recommended.

Up to 1905 three resections carried out in Sauerbruch's chamber at the Breslau Clinic had ended fatally, and this writer (*Journal of Amer. Med. Assoc.*, Sept., 1908) says that he has employed this method in nine fatal cases.

Sauerbruch (*München. Med. Wochenschr.*, 1906, vol. liii, p. 1) has further elaborated the methods of operation by experiments on dogs. These experiments and five operations performed on the human being for the resection of œsophageal carcinomata were all carried out under negative

thoracic pressure within his pneumatic chamber (see Fig. 116). The incision was placed over the fifth or seventh intercostal space, and was followed by removal of the adjacent ribs or their temporary resection. The pleura was widely opened and the growth exposed after the vagi had been carefully isolated.

Experimentally Sauerbruch has devised two operations, which will be indicated under different conditions. In the first an œsophago-gastrostomy with a Murphy's button is performed, after which the

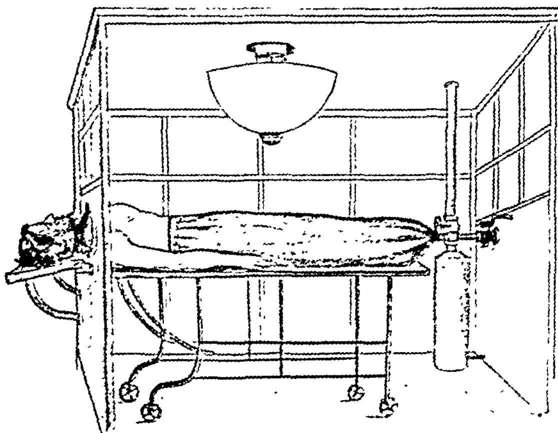


FIG. 116. SAUERBRUCH'S CHAMBER. By permission of Dr. Sauerbruch.

required portion of the œsophagus is resected. In the second operation, especially suitable for growths near the cardiac end of the œsophagus, the affected portion of this tube is invaginated into the stomach, and secured in this position by sutures connecting the circumference of the œsophagus above the growth to the stomach-wall. At a second operation gastrostomy is performed, and the invaginated portion of the œsophagus bearing the malignant tumour is excised.

Of the first five operations performed by Sauerbruch, all of which ended fatally, two cases, in which inoperable carcinoma was present, were complicated by perforation of the malignant growth, owing to which

an empyema resulted, with death in fourteen days; in a third case the cause of death was undiscovered. A fourth operation consisted in resection of the lower portion of the œsophagus for carcinoma of the cardia. In a fifth case, in which there was a large tumour of the cardia, resection was abandoned owing to the general condition of the patient, and anastomosis performed, the patient dying twenty-four hours after the operation. Sauerbruch states that during the entire intrapleural operation the pulse and respiration remained normal.

Dangers and difficulties. *Hæmorrhage.* During the resection of the thoracic wall this will be severe, and must be dealt with by promptly seizing all bleeding points with Spencer Wells's forceps; the intercostal arteries must be taken up and ligatured before they are divided. Bleeding from one of the venæ azygoi or from a tributary may be troublesome on account of the depth of the wound, and in securing these with forceps care must be exercised that only the bleeding vessel is taken up; otherwise damage to important structures, such as the thoracic duct or the vagi, may result.

Injury to the Pleura. This is by far the most important danger of these trans-mediastinal operations, and the risks of injury to the right pleura will be appreciated when it is borne in mind that it is necessary for the patient to lie in the semi-prone position on the left side, so that while movements of the left lung are impaired entry of air into the right pleura may be followed by an immediately fatal issue. For this reason von Mikulicz made use of Sauerbruch's negative air-pressure chamber, and his example has been followed by the general use of a similar apparatus in the performance of such operations.

This chamber (see Fig. 116) is large enough to receive five persons if required, and in it the operator works at a negative air-pressure of 3 to 5 millimetres of mercury, which is increased to 7 or 8 mm. towards the close of the operation. According to Sauerbruch, opinion is now in favour of decreasing the thoracic pressure, the bronchial pressure remaining normal, as opposed to the alternative of increasing the pressure within the lungs while the thoracic cavity is exposed to normal atmospheric pressure as is done in most physiological experiments. (For further interesting details see Sauerbruch, 'Zur Pathologie des offenen Pneumothorax und die Grundlage meines Verfahrens zu seiner Ausschaltung,' *Mitteilungen aus den Grenzgebieten der Medizin und Chirurgie*, 1904, vol. xiii, p. 461.)

Empyema and infection of the mediastinal cellular tissues. Avoidance of injury to the pleura and drainage in all cases are the best means of avoiding the above, but it must be borne in mind in estimating the risks of these operations that the pleura has little of the tendency so favourably exercised by the peritoneum of limiting infection by the

thoracic pressure within his pneumatic chamber (see Fig. 116). The incision was placed over the fifth or seventh intercostal space, and was followed by removal of the adjacent ribs or their temporary resection. The pleura was widely opened and the growth exposed after the vagi had been carefully isolated.

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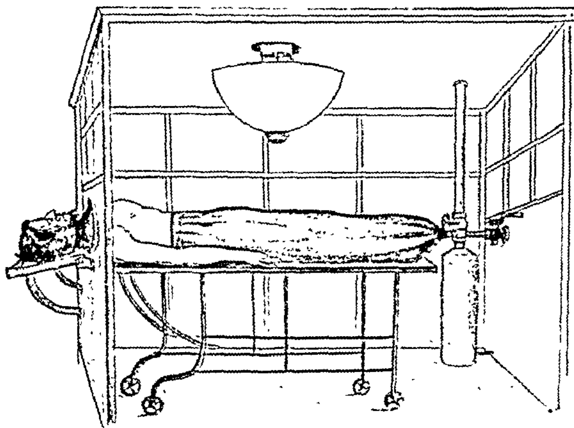


FIG. 116. SAUERBRUCH'S CHAMBER. By permission of Dr. Sauerbruch.

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Of the first five operations performed by Sauerbruch, all of which ended fatally, two cases, in which inoperable carcinoma was present, were complicated by perforation of the malignant growth, owing to which

to allow of the passage of a very large stream of water. Some suppuration occurred, and a sinus formed over the clavicle, leading into the newly formed œsophagus, and six weeks later there was a gastric fistula, the margins of which were adherent to the lower opening of the skin tube. Secondary sutures were therefore placed in the newly formed tube near the clavicle, and the skin over the fistula sutured. The stricture in the œsophageal tube was impermeable. A week later thin fluid nourishment was introduced into the artificial œsophagus from above, and entered the stomach without difficulty. The external skin sutures over the tube had to be removed owing to tension, the sutures around the fistula between the stomach and artificial œsophagus being well retained. Three days later pulmonary embolism occurred, terminating fatally. *Post-mortem examination* showed that the sutures were not retained at some points in the artificial œsophagus, and that there were small openings through which water flowed. Death was due to carcinoma of the œsophagus, mesentery, and uterus, embolism of the right pulmonary artery, œdema of the lung, and degeneration of the heart. In another case in which the procedure was employed the patient also succumbed to intercurrent complications. Failing this, definite closure of the wound might have been obtained by secondary operation and union have been established with the œsophagus, so that an artificial œsophagus would have been formed from skin. Bircher thinks that though peristalsis could not be obtained in the artificial tube, fluids would easily pass through it, and he believes that eventually it might be possible to form an artificial œsophagus in this way, especially if strict asepsis were maintained.

ŒSOPHAGO-PLICATION

Reisinger (*Verhandl. d. Deutsch. Ges. f. Chir.*, 1907, vol. xxxvi, p. 86) performed the following operation on a patient in whom dilatation of the œsophagus was diagnosed :—

The X-rays showed that almost the entire thoracic portion of the œsophagus was enormously dilated. The posterior mediastinum was opened from the right side, according to the method of Rehn, Nasiloff, and Bryant. A flap of skin and muscle was formed, with its base upon the spinous processes of the third to the eighth thoracic vertebræ, and its apex extending to the median border of the scapula. Portions of the fourth to the seventh ribs, 6 to 7 centimetres in length, were resected, the intercostal musculature removed, and the pleura loosened from the vertebral column. Practically the entire thoracic portion of the œsophagus was laid bare, carefully avoiding injury to the neighbouring structures, especially the pleura, and the œsophagus was seen as an enormously dilated thick-walled tube. An attempt was made to carry out œsophago-

rapid formation of adhesions, so that even when drainage is employed infection may be carried in from without and an empyema may result.

Modifications. Several ingenious plastic operations have been devised in order to obviate the discomfort of a permanent gastric fistula after resection of the œsophagus, and of these the following are the most suggestive.

Roux (*Sem. Méd.*, January 23, 1907) operated upon a child suffering from simple stenosis of the œsophagus which had resisted all attempts at mechanical dilatation. He freed a sufficiently long portion of the jejunum, and ligatured four to five arteries leading to it at suitable distances from the intestine. Owing to the conditions of vascular supply in the jejunum the blood was not cut off from it, but was received from the vasa recta. The portion of intestine was sufficiently long to be brought to the abdominal wound. The anal end of the portion of jejunum was inserted into the wall of the stomach, the upper end being drawn out of the abdominal wound. The skin of the thorax was then undermined from a longitudinal incision over the upper end of the sternum, and the portion of jejunum drawn through the cutaneous bridge from the abdominal wound to the wound above. The twisted end of the jejunum was sutured to the skin in the thoracic wound, and nourishment given through an œsophageal tube. There was always good pulsation in the arteries supplying the jejunum. The abdominal fascia and rectus abdominis were slightly cut so as to allow plenty of room for the passage of the intestine, and the skin wound was closed. The result was favourable, the portion of intestine being seen to contract under the skin, and there was no difficulty in suturing the œsophagus to the upper end of the portion of jejunum at a later operation.

In carcinoma of the œsophagus Bircher (*Centralb. f. Chir.*, 1907, vol. xxxiv, p. 1479) devised another procedure, in order to restore the defect in the alimentary canal by forming an artificial œsophagus. He performed the operation in a very emaciated woman with stenosis of the œsophagus 31 centimetres below the teeth: the patient's history pointed to the presence of carcinoma. Two parallel skin incisions were made, from the submaxillary region to the costal margin, that on the left being somewhat outside the median line, while the right one lay just inside the nipple line. The margins of this median strip of skin were turned over and united by interrupted sutures, forming a tube covered internally by epidermis. The skin on each side of the turned-over portion was undermined and the edges approximated and sutured over this tube, so that it was covered completely by skin, and had an opening only above and below.

Three days later the patency of the tube was tested, and it was found

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SECTION IV

OPERATIONS UPON THE STOMACH AND INTESTINES

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OPERATIONS UPON THE STOMACH

BY

B. G. A. MOYNIHAN, M.S. (Lond.), F.R.C.S. (Eng.)
Surgeon to the Leeds General Infirmary

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CHAPTER I

PREPARATION AND AFTER-TREATMENT OF PATIENTS OPERATED UPON FOR DISEASES OF THE STOMACH

No insignificant part of the successful treatment of patients operated upon for diseases of the stomach depends upon the care exercised in the preparation and in the conduct of the case subsequent to operation.

PREPARATION OF THE PATIENT

The usual precautions necessary to secure asepsis are more than ever necessary here. It is not seldom that one hears the remark that the 'margin for error' is greater in abdominal surgery than it is in the surgery of other parts. And it is quite true that the peritoneum has a great capacity for dealing with any infection introduced into it. But there can be no question that the more sedulously the details of an aseptic operation are observed, the speedier is the recovery of the patient. Many of the troublesome after-effects of an abdominal operation—pain, flatulence, hiccough, vomiting—are due to infection. They are evidence of a slight peritoneal response to an infection. The patient upon whom such an operation as gastro-enterostomy has been performed should suffer almost no discomfort after he has recovered from the anæsthetic. There should be no pain except a 'catch' in the wound on coughing or sneezing.

The chief infection in an operation comes from the patient's skin. If this be carefully prepared it may be rendered sterile, so that a little piece of the skin snipped away at the beginning of the operation, and dropped into a culture-medium, displays no evidence of infection. But an examination of the skin, similarly conducted, at the middle or end of the operation will show that infection is present. The surface of the skin is infected from the depths. It is my practice therefore always to cover the skin by fixing up to the edges of the wound with a special forceps the 'tetra' material, which consists of many layers of compressed gauze. When the stomach or omentum is taken from the abdomen there is no chance of any infection occurring from contact with the skin.

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It is of great importance to secure before operation the cleanliness of the stomach and the jejunum. Some of the cases submitted to

gastrectomy or gastro-enterostomy have enormously enlarged stomachs in which food lies stagnant. The discharge from an ulcer or a growth makes such retained material foul and intensely infectious. In these cases, indeed in all cases, every endeavour should be made to get the stomach thoroughly clean before the abdomen is opened. Lavage secures this end more certainly than anything else. The stomach, if stasis be present, is washed out twice a day for several days, and time and pains are spent on each occasion. It may be necessary to use many gallons of fluid—sterilized saline solution is the best—before the water returns clear. If there be no evidence of stasis the stomach need not be washed more than twice, once twenty-four hours before the operation, and the second time an hour before. The opportunity should be taken to give test-meals, when the stomach is washed, for purposes of investigation. Some of the patients who have suffered long from vomiting are very thin, emaciated, parched for lack of water. In them the continuous administration of saline solution by the rectum, or hypodermically, may prove very beneficial. It is most important also to attend to the condition of the patient's mouth. In almost all cases of stomach diseases the mouth is in an unsatisfactory condition; indeed oral sepsis not improbably plays a part in the causation of many organic diseases of the stomach or intestine. The teeth should be thoroughly cleaned several times daily, and a fragrant mouth-wash used at frequent intervals.

SUTURE OF THE ABDOMINAL WOUND

A few transverse scratches are made with a fine needle in the skin at right angles to the line of the intended incision. The abdominal incision is carried through the right rectus muscle in gastro-enterostomy, in the middle line usually for gastrectomy. The fibres of the rectus are split, the nerves being preserved, if possible, or the whole belly of the muscle is displaced outwards. As soon as the peritoneum is reached, and before it is opened, 'tetra' cloths are fixed over the edges of the wound, and fixed at each side and at each end by the special forceps made for me by Down Bros. The wound is sutured in several layers. A continuous catgut stitch is taken from one end of the wound to the other, picking up the posterior sheath of the rectus and the peritoneum together. The needle is then laid aside. Then with a long straight needle interrupted sutures of silkworm-gut are passed through skin and rectus muscle on each side. The needle is introduced on one side and brought out on the other through one of the faint scratches made in the skin before the incision was started. About six or eight of these sutures are passed, and the ends of all are then seized by a clip on each side. The needle carrying the catgut suture, which has just been laid aside, is

again taken up, and is made to return along the incision; it now picks up the anterior sheath of the rectus on each side. On the left side it is introduced about ½ inch from the cut edge of the sheath, and is brought out just clear of the cut margin; it therefore picks up a transverse piece of the anterior sheath. On the right side the needle passes from the deep to the superficial aspect of the sheath. On pulling the suture tight it will be found that the right edge of the fascia overlaps the left edge. The fascia is approximated therefore by flat surfaces, and not by edges only, and this makes for sounder healing. When the end of the wound is reached, the catgut is tied to the original end of the suture which had been left long. Then at each end of the skin incision a small volsella is placed, and one or two along the wound, bringing the scratches accurately together. A row of Michel's clips are then put in and the skin edges thus accurately brought into contact. The silkworm-gut sutures are now tied rather loosely, and cut short. The dressing I use consists of four layers of gauze laid along the wound (the skin being previously washed over with spirit). Over this a large square of gauze is placed; a piece of stout gauze bandage is the best. This bandage is then fixed to the skin by a solution of formalin and gelatine applied hot. In a test tube an ounce of gelatine (20% in water) has been previously sterilized on three successive days by heating to 100° C. Just before use the test tube is put to stand in very hot water until the gelatine is liquefied. To it then are added α) 20 of a 4% solution of formalin. The solution is then rapidly applied to the gauze bandage, which it attaches firmly to the skin. The dressing dries in about one minute; over it a thin layer of wool is applied to prevent the blankets or the clothes from sticking to it. No bandages are used. I never use any abdominal bandage now unless a drainage tube is left in the wound. The dressing I have described is very comfortable; it covers only the wound, and leaves the rest of the abdomen open to inspection or palpation.

The Michel's clips are removed in forty-eight hours. The deep stitches remain ten days or longer according to the case. In malignant cases I often allow them to remain for three weeks.

AFTER-TREATMENT

As soon as the operation has been completed the patient is placed in a warm bed, lying on the back with one pillow. After an hour or two, as soon that is as the effect of the anæsthetic is passing off, the patient is propped up in bed with a bed-rest or five or six pillows. This position is one of great comfort to the patient, but it is difficult to maintain. There is a very marked tendency, for a heavy man particularly, to slide down in the bed. A most useful device for

keeping the patient in the sitting position is that suggested by Dr. Cairns Forsyth. A hard round pillow covered with mackintosh and a pillow-slip is placed beneath the patient's thighs, immediately below the buttocks. To each end of this pillow a stout strap is attached, terminating in a buckle. A second strap is fixed to the upright end of the bed, and its lower end engages with the buckle attached to the pillow; by



FIG. 117. POSITION OF THE PATIENT AFTER OPERATIONS UPON THE STOMACH.

pulling this strap tight and fixing it, the position of the pillow is made secure. The patient is supported by this pillow quite comfortably, and is prevented from slipping down in the bed. About five or six hours after the operation the feeling of nausea caused by the ether will have passed off, and the patient begins to ask for fluid. At once water is given, an ounce or more at a time to begin with, and in two or three hours a cup of tea. Most patients like tea better than any other drink; during the first twenty-four hours three or four cups, made to the patient's liking, may be given. I do not restrict the quantity of water allowed to

patients. They rarely drink more than 20 or 30 ounces in the first twenty-four hours, but it is their own desire which regulates the quantity given, not any order of mine. There is no harm done by giving fluids freely. If a patient can vomit without injury to the suture line, it is quite certain that the passage of fluids through the anastomotic opening will do no hurt. For the last three or four years I have put no restraint upon patients in this matter even from the first. Thirst is the most intolerable of all sufferings after abdominal section, and there is no justification for allowing a patient to suffer from it. Fluid taken by the mouth has to pass to the large intestine to be absorbed. The intestines are kept active, therefore, and this is entirely an advantage. I do not order solid food until a patient himself asks for it. In the early days milk, soups, tea and cocoa are given freely, but solid food is not desired by a patient until eight or ten days have passed. As soon as the request is made I grant it, ordering sweetbread, fish, bread and butter, mince, and so on, and the quantities taken are not restricted. In eighteen or twenty days ordinary food can be taken and enjoyed. I discourage pastry, fresh fruits, and green vegetables in all cases for some time, for these things are without value as foods.

On the night of the operation the patient may be allowed ¼ gr. of morphine hypodermically. There is usually not much pain after the operation involving the stomach, but if the patient complains of pain I do not hesitate to give one hypodermic injection of morphine. It is extremely rare for a secqnd dose to be asked for or to be given. In all cases a simple enema, with or without turpentine, is given twenty-four hours after the operation. Flatus is brought away, and the patient is more comfortable. An aperient, castor oil or calomel, is given about the fifth day. The patient is allowed up sometimes during the second week, usually on the ninth or tenth day. In malignant cases I get the patients out of bed earlier than this, often on the day after operation.

CHAPTER II

GASTROTOMY: GASTROSTOMY: PARTIAL GASTRECTOMY

GASTROTOMY

Indications. In the operation of gastrotomy the stomach is opened for the purpose of exploring its interior, for the removal of *a foreign body, or for obtaining access to the cardiac orifice when retrograde* dilatation of an œsophageal stricture is to be attempted. When the purpose of the operation has been fulfilled the opening in the stomach is closed, and the viscus is returned within the abdomen.

Operation. The abdomen is opened in or near the middle line, according as access to the cardiac or the pyloric extremities of the stomach is to be obtained. The rectus muscle, when a lateral incision is used, is split or displaced in the usual manner. When the stomach is exposed, it is drawn well into the ample wound. The peritoneal cavity is then protected by two layers of gauze swabs introduced into it. Those swabs first packed away are of large size, and remain unmoved throughout the operation; a more superficial layer consists of smaller swabs which are changed when necessary. The edges of the abdominal incision are also well protected by gauze packing or by 'tetra' cloths. In addition to the stomach the transverse colon should be drawn well into the wound, for it may be necessary to tear through the gastro-colic omentum in order to reach the posterior surface of the viscus. The stomach is then opened either by a vertical or by a transverse incision. The latter is to be preferred as it gives a better exposure of the stomach, though, since more vessels are necessarily divided, the hæmorrhage is more severe. As the vessels are divided they are seized and ligatured at once with fine catgut. A fine volsella then seizes each edge of the wound and the stomach cavity is open to inspection. A good deal of frothy viscid mucus may be found in the interior; it is to be mopped away with gauze. The foreign body (a dental plate, or a hair ball or other intruder) is to be removed, or the intended procedure carried out, and the wound in the anterior wall closed. If a close inspection of the stomach be necessary, one or two fingers are passed through a rent in the gastro-colic omentum immediately below the stomach, a bloodless spot being chosen, and the posterior wall protruded through the anterior opening.

One portion after another of the stomach-walls may thus be passed in review, and may be dealt with as is necessary.

The opening in the stomach is closed by two layers, an inner suture of catgut introduced by the 'loop on the mucosa stitch', and an outer sero-muscular suture of Pagenstecher's thread. The stomach is then cleansed by wiping with moist sterile swabs, the gauze packing and the protecting swabs are removed and the abdomen closed.

GASTROSTOMY

Indications. The operation of gastrostomy is performed in those cases where there is stenosis of the œsophagus, or at the cardiac orifice of the stomach, to a degree which renders the passage of nourishment so difficult that life cannot long be maintained.

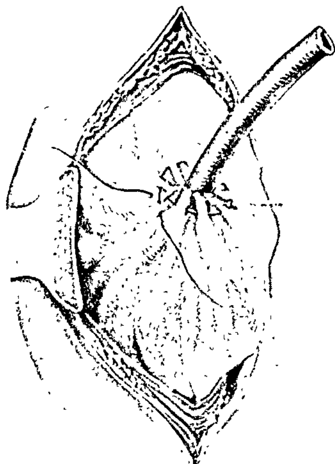


Fig. 118. Gastrostomy by Senn's Method. The suture placed.

Operation. A great variety of procedures have been adopted in the search for a perfect method. There is at present a choice of several operations which fulfil well the necessary conditions. These are that the operation should be simple and speedy, for the vitality of patients needing the operation is small; that it should give adequate access to the stomach; that it should not permit the regurgitation of fluids or of gastric juice; and that the external opening should show no great tendency to spontaneous closure.

Senn's method. In my judgment this is the most satisfactory of all methods, for it best fulfils the necessary conditions which have been

already enumerated. It consists in the infolding of a cone of the anterior wall by a series of purse-string sutures around a central tube which passes into the cavity of the stomach. The abdomen is opened by a vertical incision 2 to 3 inches in length through the outer part of the left rectus immediately below the costal margin. The muscle fibres are split, care being taken not to fray them, and the peritoneum incised.

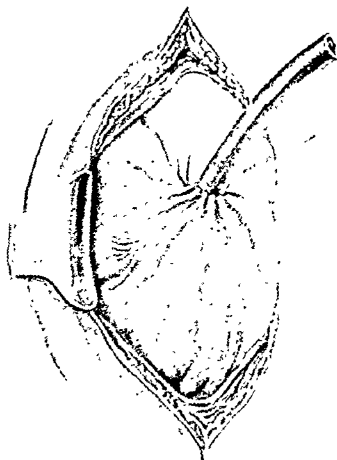


FIG. 119. GASTROSTOMY BY SENN'S METHOD. The suture tied.

The stomach is then exposed; it is often, indeed usually, found small and shrunken, and hidden beneath the hollow of the ribs under the shelter of the left lobe of the liver. It is pulled well up into the wound, and a point upon it selected for the introduction of the tube. This point should be as far away from the pylorus as is convenient, and it should be approximately midway between the curvatures. The stomach is now surrounded with small gauze packs, to prevent soiling of the wound. At the point chosen a small incision is made into the anterior wall of the stomach, through all the coats. Through this opening a rubber catheter (Jaques's No. 12) or a piece of small drainage tube is passed towards the pylorus for a distance of 2 or 3 inches. The edge of the incision and the tube are now both caught up in a needle which carries a catgut thread; the stitch when tightened fixes the tube to the opening in the stomach. A series of purse-string sutures of fine Pagenstecher's thread are now passed in circles around the tube where it enters the stomach. The first of these is about $\frac{1}{4}$ inch from the tube; as it is tightened an assistant pushes the tube inwards to the stomach so that

the stitch comes to lie close against the tube. A second stitch about ¾ inch from the tube is then passed and tied in the same manner; then a third, and if need be, a fourth; each suture is tightened snugly round the tube and is then cut short. Finally, the stomach is secured to the anterior abdominal wall by a suture above and below the tube. The parietal wound is closed in layers and the operation is complete. A meal of peptonized milk may be given at once. As a rule the stomach is so small that it cannot comfortably hold more than 6 or 7 ounces, but in a few days its capacity increases. I prefer to give a meal every

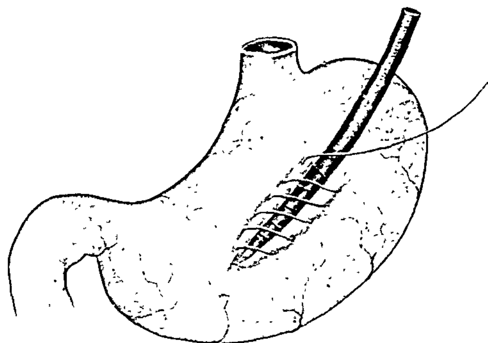


FIG. 120. GASTROSTOMY BY WITZEL'S METHOD.

four hours, and between each meal to pour a few ounces of water into the stomach, for it is fluid that these patients mainly want.

Kader's method. The principle of this is similar to that just described. A tube is introduced into the stomach at the same point as in Senn's operation. Then transverse sutures are passed which raise up vertical folds on each side of the tube. By means of the stitches, which pick up only the sero-muscular coats, two longitudinal ridges are brought together, and at the mid-point of the ridge the tube passes vertically into the stomach. As the sutures are tightened they are cut short. There are usually two above the tube and two below. A second layer of stitches, and then a third, are passed in a similar manner; and finally the stomach is fixed to the anterior abdominal wall as before.

Witzel's method. This ingenious method is useful not only in the stomach, but also in the jejunum, and its analogue is used in other

regions of the body. The method consists in introducing a tube into the stomach and fixing it by a suture, as in the two methods already described. The tube is then laid flat upon the anterior wall of the stomach and is buried in a groove or furrow there, by means of a continuous suture which picks up the sero-muscular coats, as in a Lembert's suture, first above and then below the tube. As the stitch is tightened a ridge is lifted up on each side of the tube which is thus entunnelled. The suture begins a little distance beyond the point of entry of the tube into the stomach and continues for about 2½ inches to 3 inches. *Finally, the stomach is fixed by a few stitches to the anterior abdominal wall.*

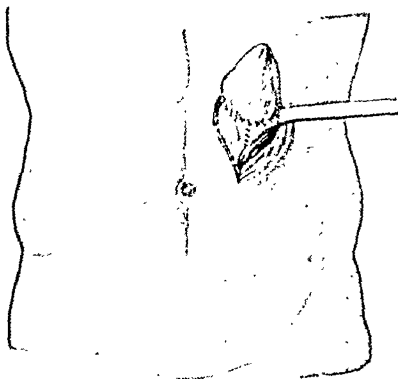


FIG. 121. GASTROSTOMY BY FRANK'S METHOD. The stomach sutured to the peritoneum.

Frank's method (Sbanajew-Frank-Albert-Kocher method). This is probably *the method* most employed at the present time, and it is certainly that which has been subjected to the greatest variety of modifications, by Kocher, Hartmann, *and others.*

The operation is thus performed: A *vertical incision over* the upper part of the left rectus muscle is made. The rectus fibres are split, or the anterior sheath of the rectus muscle dissected up to the middle line and the whole muscle displaced outwards (Kocher). The peritoneum being opened, the *stomach is sought, and a cone-shaped piece of its anterior surface* is brought well out of the wound. The base of this cone is then fixed by a running suture to the margins of the parietal peritoneum in the wound (see Fig. 121). A second incision is now made parallel to the costal margin and *1 inch* beyond its free edge; that is to say, on the wall of the thorax. Between the two incisions the subcutaneous tissue is then cut through by scissors, in such manner as to raise up a bridge of skin, which, as it

were, roofs in a tunnel in the subcutaneous tissue. Through this tunnel and beneath this bridge of skin the cone-shaped piece of the stomach is passed until the apex of the cone pouts through the thoracic incision. It is there fixed by a hare-lip pin or a few sutures, and the original abdominal wound is then closed completely (see Fig. 122). This method is one which is in my opinion distinctly inferior to Senn's operation. For in all cases of œsophageal obstruction the stomach is small; it is accordingly by no means an easy matter to bring so much of it out of the abdomen as is necessary to make a good subcutaneous fold. Moreover, so much of the stomach as is employed in the operation is put out of use, as it were, so far as any digestive or other function is concerned; whereas in Senn's and Kader's operations the stomach-wall being infolded is not deprived thereby of its function. The efficacy of the 'valve action' is certainly not one whit better than in Senn's operation; indeed it is not, I think, quite so consistently secure. Finally, the time consumed in the operation is a little longer, and in patients who are seriously ill this is a factor not to be disregarded.

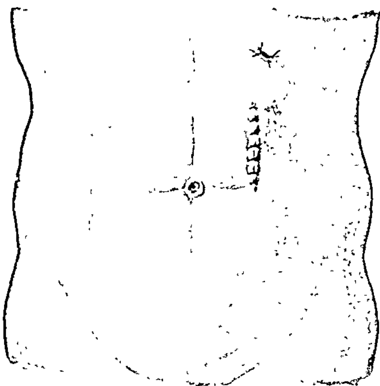


FIG. 122. GASTROSTOMY BY FRANK'S METHOD. The stomach sutured to the skin and the wound closed.

Tavel's method. This most ingenious method consists in fastening a tube—an œsophagus, so to speak—between the anterior abdominal wall and the stomach by utilizing a resected portion of the small intestine.

A free incision is made through the left rectus muscle, reaching to the umbilicus. The stomach is sought, and then the omentum is lifted up and the jejunum brought up into the wound for examination. A piece of it is then selected which is well supplied with blood (any chance piece will not do) and is then clamped by two pairs of clamps above and below. Between the clamps the bowel is cut, and the ends above and below the

resected length are united by suture. The intestinal continuity is thus restored, and a piece of the jejunum some inches in length, still attached by its mesentery, which contains a free blood-supply, is available for the purposes of the new 'œsophagus'. This piece of the bowel is now united at one end to the stomach and at the other to the abdominal wall, and the parietal wound is closed around it. The description of this operation is enough to convince any surgeon that for most cases requiring gastrostomy it is quite inadmissible. It is too severe and too prolonged a measure for a weakly and wasted patient to bear. But for cases of simple œsophageal obstruction it may occasionally be useful. A very striking use of the method has been made by Roux of Lausanne, who, in the case of a boy aged about eight who had an impermeable stenosis of the œsophagus due to the swallowing of a caustic fluid, brought a long piece of the jejunum (attached at the lower end to the stomach) upwards beneath the skin of the abdomen and chest to a point a little below the manubrium sterni. The boy, whom I saw many months after the operation, was fat and well, and the new œsophagus acted perfectly.

After-treatment. After the operation of gastrostomy has been performed the patient should be fed at frequent intervals. At first about 5 ounces should be given every one and a half to two hours. Peptonized milk with a little brandy is given at first, and between the meals a little water is allowed to run into the stomach. It relieves the patient's thirst and prevents coagulated milk from blocking the tube. During the first few days no more than 6 or 8 ounces at one time can be received into the stomach with comfort; a quantity larger than this causes distress, and the fluid may regurgitate if the stomach be over-distended. After a few days the stomach may be washed out through the tube, and a dose of castor oil administered. Patients often express a desire to have something in their mouths, the flavour of which they can appreciate. I usually allow them to sip any favourite drink, for after gastrostomy has been performed the power to swallow is often much improved and a fair quantity of fluids can be given by the mouth. But I prefer to give all the necessary food by the tube, allowing by the mouth only those well-flavoured drinks for which the patient has a special liking. Some days later meat may be chewed and spat out into a funnel, and washed thence into the stomach. The tube can usually be removed at the end of eight or ten days; it is boiled and replaced, or a new one used. The patient should be instructed not to remove the tube except for cleansing purposes. The tube is brought through an opening in a pad affixed to a belt which encircles the abdomen; this is the most convenient method of fixing it. Patients

should not be allowed to remain in bed for more than three to five days after this operation; as a rule the sooner they are up the better, and they should early receive instruction in the details of feeding, so that they may depend entirely upon themselves for this. The most distressing complication after this operation is hiccough. It occurs to a greater or less degree in about one-fourth of the cases; it is relieved by washing out the stomach, and by small doses of morphine or cocaine.

PARTIAL GASTRECTOMY

In planning an operation for the removal of a cancer beginning in or near the pylorus the lines which the procedure must follow are determined by a consideration of certain factors. These are—

1. The lymphatic system of the stomach.
2. The mode of spreading of the growth in the stomach.
3. The involvement of the duodenum.

1. *The lymphatic system of the stomach.* The lymph vascular supply of the stomach is free. For convenience of description certain territories are marked out upon the stomach, which may be looked upon as watersheds, each draining into a separate group of glands. Cunéo describes three such areas, which are marked out by drawing two lines upon the stomach. The first line extends from the apex of the fundus to the middle of the pylorus and passes across the stomach at the junction of its upper two-thirds with the lower third. The second line extends from the mid-point of the greater curvature vertically upwards to meet the first line. In this way three areas are marked out: from the upper all the lymph-vessels flow to the glands along the lesser curvature and to those around the cardiac orifice; from the left lower area the vessels pass to the spleen, and from the right lower area they run obliquely downwards to glands which lie along the greater curvature close to and beyond the pylorus. The glands into which these vessels run direct are called 'primary'. When a gland receives vessels which have already passed through other glands it is called 'secondary'. It is clear that if good is to be done by any surgical procedure involving the removal of a cancer, not only must the growth itself be taken away, but also all the lymphatic vessels which drain the region in which the growth lies and the primary glands which drain that area. The primary glands are—

(*a*) Those which lie along the coronary artery.

(*b*) A gland or glands lying above the pylorus, by the side of the pyloric artery, the 'suprapyloric' gland.

(*c*) Glands which lie along the upper border of the pancreas, to the right of the cœliac axis, the 'right suprapancreatic' glands.

(*d*) The glands which lie along the greater curvature in association with the right gastro-epiploic artery.

(*e*) Retropyloric glands.

All these glands must be removed therefore as well as the stomach.

2. *The local increase of the growth in the stomach.* The apparent size of a growth in the stomach is no guide to its actual size; for all around the palpable growth an extensive invasion of the submucosa has occurred. This invasion in cases of pyloric growth extends for at least an inch on the cardiac side. The growth, moreover, shows a striking tendency to invade the curvatures, especially the lesser curvature. It is not uncommon to find a solid cord of growth extending from a small pyloric growth quite up to the cardiac end of the stomach along the lesser curvature. It is therefore necessary in all cases of resection of the stomach to take away the whole length of the lesser curvature.

3. *The involvement of the duodenum.* As a general rule a pyloric cancer seems to stop abruptly at the duodenum, and comment has been made by a multitude of authors upon the integrity of the intestine in cases of gastric cancer. But as a result of the work of Cunéo and Borrmann we have been brought to realize that an invasion of the duodenum is by no means infrequent. Borrmann examined sixty-three specimens removed by operation and found that in no less than twenty was it evident that the cut surface of the duodenum was involved in the growth. At least one inch of the duodenum must accordingly be removed.

The lines therefore which a resection of the stomach should follow may be indicated. The whole growth with a wide margin should be taken away; all the lesser curvature and one-half of the greater curvature must be removed, and all the primary glands must be sacrificed.

Operation. The operation is carried out in the following manner: An ample incision is made in the middle line, reaching as a rule from the ensiform cartilage to the umbilicus. The central incision is more convenient than the lateral incision which is commonly employed for the operation of gastro-enterostomy; it gives easier and more immediate access to all parts of the operation area. An inspection of the extent of the cancerous invasion of the stomach itself, of its adhesion to the pancreas or abdominal wall or liver, of the number and position of any glandular enlargements, and finally of the liver, peritoneum, and parts immediately in the neighbourhood to discover if secondary growth be present, is made. Neither adhesions nor the involvement of lymphatic glands preclude removal of the stomach, though they may render the mechanical difficulties rather more serious. When a resection has been decided upon, flat gauze swabs, wrung out of hot saline solution, are packed round the stomach so as to afford a barrier between the field of

work and the general peritoneal cavity. As a rule two layers of swabs are introduced, the first consisting of very large ones, which are unchanged throughout the operation, and the second of smaller ones, which when soiled are changed at once. No care is too punctilious so long as absolute security of the peritoneal cavity is ensured.

It is best to begin the operation by ligature of the principal arteries of supply so as to render the operation comparatively bloodless. I formerly began by ligature of the coronary artery, but now prefer to leave this vessel until a later stage of the operation for reasons presently to be mentioned. The gastro-hepatic omentum is first torn through, and if need be ligatured close to its attachment to the liver, beginning near the cardia, and the omentum stripped down to the stomach, and to the right until the pyloric and gastro-duodenal branches of the hepatic artery are exposed. These vessels may arise together or separately from the hepatic stem. They are best defined by stripping along the hepatic artery with gauze wrapped round the finger. Each vessel is surrounded by an aneurysm needle carrying a double thread; between the ligatures each artery is divided. The gastro-epiploica sinistra is now tied in a similar manner at the point on the greater curvature of the stomach at which its section is to be made. The index and middle finger of the left hand are now passed from above downwards through the opening made in the gastro-hepatic omentum, behind the pylorus, where they are made to project below the duodenum, through the great omentum. In this way any adhesion of the growth to the pancreas is felt. If such adhesion be firm, a thick fibrous mass welding the two together, it is better not to endeavour to separate the stomach, but to deal first with the duodenum. The finger which projects below the duodenum indicates the point at which a clamp is introduced at the place where the bowel is to be divided. As a rule two clamps are introduced, a rubber-covered distal one and a bare proximal one; between them the duodenum is divided, a full inch beyond the pylorus. The proximal cut end of the duodenum may show a tendency to slip away from the clamp; this is prevented by passing a couple of sutures through the stomach and tying them over the clamp. The distal end of the duodenum may be closed by one of several methods. I prefer a running suture of catgut taken from top to bottom and drawn tight; its two ends are tied together in such manner as to pucker up the suture line to a small knot. Outside this a continuous Pagenstecher's suture is passed until it is quite certain that a perfectly secure closure of the duodenum has been effected. I generally use a third layer of stitches, for the records of cases show that leakage from the duodenum is one of the common causes of disaster. I have never had any trouble from this source, but I perform this part

(*d*) The glands which lie along the greater curvature in association with the right gastro-epiploic artery.

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The proximal cut end of the duodenum is now lifted up with the clamp, the whole being held in a large moist swab. If only slender adhesions to the pancreas be found they are torn through, but if the stomach seems rather to have grown into the gland it is better to slice away a thin layer from the surface. The pancreas may be safely cut

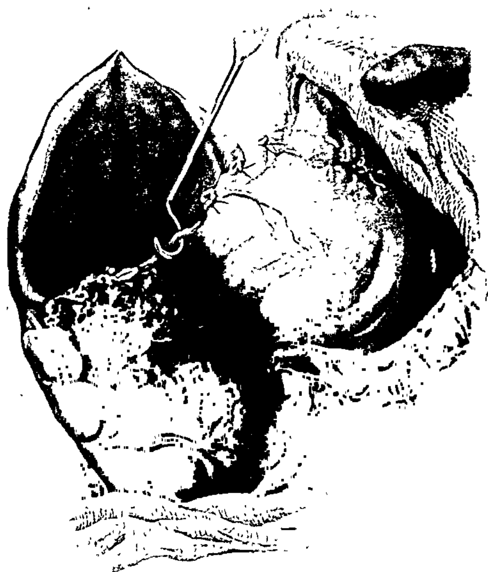


FIG. 124. PARTIAL GASTRECTOMY. Ligature of the coronary artery.

in this way, but the shaving must not be carried too deep lest the duct be opened. Bleeding is free at the first, but is readily checked by firm pressure, or by a few ligatures.

It is now the time to see that all the glands along the greater curvature of the stomach are removed. The subpyloric glands are often grossly enlarged, but not always so. It is important to see that all the fatty

of the operation with the most sedulous care. If need be, a part of the pancreas is stitched over the end of the duodenum to make assurance doubly sure.

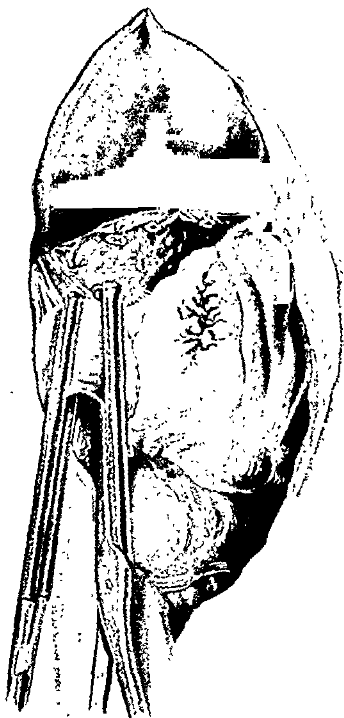


FIG. 123. PARTIAL GASTRECTOMY.
Gastro-hepatic omentum ligatured; division of duodenum.

hot swab is now turned well over to the left, so that its posterior surface is exposed. The time has come for ligature of the coronary artery. This is best done now by cleaning with a little gauze, which soon clearly displays the cœliac axis. The coronary artery is surrounded with an aneurysm needle close to its origin, tied and divided. The stomach is at once much looser, for its chief remaining anchor has been cut. The advantages of dividing the coronary at this stage are, that it is easier,

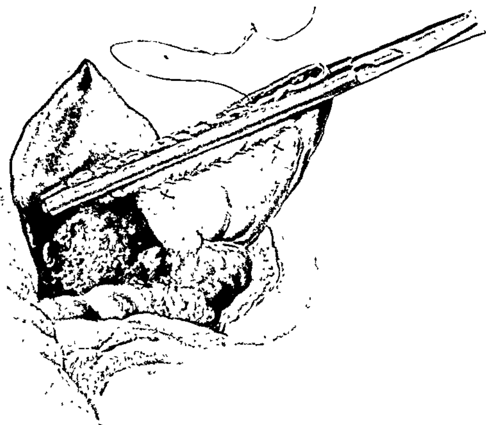


FIG. 126. PARTIAL GASTRECTOMY.
Closure of the wound in the stomach. × ×, the gastro-enterostomy suture.

being displayed in a few moments, and that it is divided at a higher point, so that the upper coronary group of glands can be removed completely. The artery being divided, the glands are stripped down with gauze until the œsophagus and the beginning of the lesser curvature are clear. The line of division of the stomach from the highest point of the lesser curvature to a point about the middle of the greater curvature is now determined, and a clamp may temporarily be laid along this line, and lightly clamped to indicate its direction. But before the stomach is divided along this line the anastomosis with the jejunum should be made. At this stage it is easily done, for the loosened part of the stomach gives one a handle

tissue which bears them, in the angle between the first and second parts of the duodenum, is taken away. On the greater curvature of the stomach the glands are also numerous in the pyloric half. They show a great tendency to drop down in the omentum; not seldom being found 1½ to 2 inches from the stomach. As these are removed it is necessary to see that no damage is done to the middle colic artery. To prevent this most serious mishap the transverse colon and omentum should be withdrawn from the abdomen and the under surface of the transverse meso-

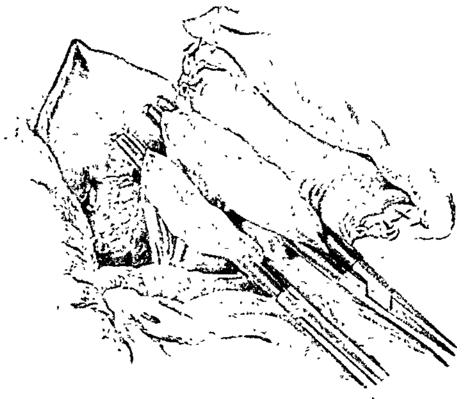


FIG. 125. PARTIAL GASTRECTOMY.
The clamps applied, preparatory to gastro-enterostomy.

colon, whereon the arterial arch is easily to be seen, constantly examined. The great omentum well below the greater curvature of the stomach is then ligatured in bundles and divided. As each part of the omentum is displayed care must be taken to see that the ligature lies well below all glands to be removed. This process of tying the omentum in bundles is continued until a point an inch or more beyond the middle of the greater curvature, well beyond the left of the glandular chain, is reached. It is at this point that the left gastro-epiploic artery has already been tied.

The stomach is now free and mobile in its pyloric half—for the gastro-hepatic omentum has been divided, the duodenum severed, and the great omentum ligatured. This mass of the stomach held in a large

indications for this operation are chiefly two: firstly, when there are multiple ulcers in the stomach; secondly, when the ulcer is so much indurated that an accurate discrimination between simple and early carcinomatous disease is very difficult, or even impossible. The advocacy of resection for such conditions began with Dr. W. L. Rodman of Philadelphia, and the name of this distinguished surgeon is now generally given to the operation for removal of the 'ulcer-bearing area'. The procedure in such cases is very similar to that which has already been described in cases of carcinoma. The chief differences are—

(*a*) It is not necessary to remove the stomach very wide of the growth; an interval sufficient to allow of the easy application of the clamps is all that is needed.

(*b*) The removal of the whole of the lesser curvature is not necessary.

(*c*) The sacrifice of the glands is not necessary.

(*d*) The duodenum need not be removed unless ulcers are found there also.

(*e*) The performance of an end-to-end anastomosis or of Kocher's gastro-duodenostomy may be possible; Rodman himself prefers, I think rightly, to perform gastro-enterostomy.

with which to manipulate the remainder, the part, that is, which is to be engaged in the anastomosis. If the stomach be first divided, the part that remains is sometimes so small, and handled with such great difficulty, that the performance of the gastro-enterostomy becomes very difficult, and the anastomosis when completed looks anything but shapely. By performing the short circuiting operation now it is easier, speedier, and therefore safer. I prefer in performing this anastomosis to make the jejunum lie to the left, on Mayo's line, as this is undoubtedly an advantage in cases of partial gastrectomy.

Clamps are therefore now applied to the posterior surface of the stomach, and to the jejunum, close to the flexure, drawn up through a rent in the transverse mesocolon. The lines of suture and all the details of the operation are the same as those described on p. 332. When the gastro-enterostomy is completed, Kocher's long clamp is applied to the stomach along the line already indicated. A second clamp is applied distal to it, and between the two the stomach is divided. In doing so it is well to cut first through the serous and muscular coats back and front and to strip these back a little way before dividing the mucosa: so that when this is divided and sutured it can be well covered by the exuberant outer coats. After division of all the coats the mucosa is sutured with catgut and the serosa and muscularis with Pagenstecher's thread. The only points of difficulty are at the curvatures, and here especial care must be taken to see that the closure is secure. At the point of section of the lesser curvature the stomach may sometimes seem likely to slip away from the clamp; if so, it is sutured at once, and an extra Halsted's suture may be useful to hold it secure. The time has now arrived to clear away the only remaining primary glands, the right suprapancreatic, which lie along the hepatic artery above the pancreas. This is best done by careful dissection, and the constant stripping of the parts with gauze. It is best to begin at the cœliac axis and work to the right; the pancreas may possibly have to be sacrificed in some small degree, but this does not signify. What is important is the security of the hepatic artery, and this must throughout be jealously guarded. It now remains only to clean the operation area, arrest any chance leakage of blood, to remove the swabs, and to close the abdominal wound. Drainage is not as a rule necessary unless the pancreas has been exposed; it is then desirable.

PARTIAL GASTRECTOMY FOR SIMPLE ULCER OF THE STOMACH. RESECTION OF THE ULCER-BEARING AREA. RODMAN'S OPERATION

There are occasions upon which it may be necessary to perform a resection of the pyloric region of the stomach for simple disease. The

in the subsequent manipulations pulled upwards into the wound. A secure packing of large swabs is then introduced. The area of the stomach which has to be excised is then mapped out, and clamps are applied above and below. As a rule a bayonet-shaped clamp will be found very convenient to apply on the cardiac side; an ordinary straight clamp suffices for the pyloric side. Between these two clamps a triangular

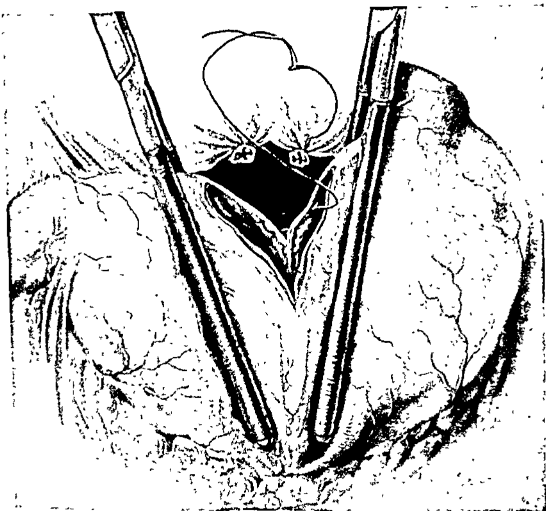


FIG. 127. EXCISION OF AN ULCER FROM THE LESSER CURVATURE

area of the stomach, bearing the ulcer, is isolated Care must be taken to see that the tips of the clamp blades do not extend too far downwards towards the greater curvature, for if too long a wedge is removed from the stomach the puckering which results may be unsightly, and may lead to stenosis. As much as possible of the healthy stomach-wall on the side towards the greater curvature is therefore left.

When the clamps are secure, the ulcer, with the triangular portion of the stomach which carries it, is excised, by snipping a little distance

CHAPTER III

OPERATIONS FOR GASTRIC ULCERS AND THEIR SEQUELÆ

EXCISION OF AN ULCER FROM THE LESSER CURVATURE

Indications. Experience has shown that when chronic ulcers are found upon the lesser curvature, in the cardiac half of the stomach, the relief from gastro-enterostomy is slight or transitory, and my practice has now been, for some time, to excise such ulcers. As a rule an ulcer so placed is solitary, and when it is removed the stomach performs its work as well as ever before, but there are cases, very exceptional I believe them to be, in which such an ulcer is found together with a chronic ulcer in the duodenum. In such circumstances the choice before the surgeon lies between the performance of gastro-enterostomy well on the cardiac side of the ulcer and the excision of the gastric ulcer followed by gastro-enterostomy. I have excised many of these saddle-shaped ulcers of the lesser curvature, but have never yet found it necessary to perform gastro-enterostomy also.

Operation. The operation may be extremely difficult, for the ulcer may be firmly adherent to the pancreas or to the liver, or it may lie so close to the cardiac orifice of the stomach that it is almost inaccessible. I have on one occasion found the operation quite as difficult as a complete gastrectomy. the case concerned a man who had been very stout, but was much wasted, and the ulcer was close to the cardia and very adherent. The ultimate result was, however, very good.

The abdomen is opened by an ample incision through the right rectus muscle and the stomach exposed. The ulcer is then investigated, and the extent and density of any adhesions carefully noted. The first step consists in the division of the gastro-hepatic omentum above the ulcer and the inclusion within the part to be removed of any glands (the 'sentinel gland' of Lund) that lie along the lesser curvature. The coronary artery on each side of the ulcer is then ligatured; this is best done by surrounding it by an aneurysm needle, which is threaded with stout catgut and withdrawn. When ligatured above and below the ulcer the artery and vein are divided. A finger is then passed behind the stomach into the lesser sac, and the part of the viscus which is involved

fall upon the abdomen to right or left of the middle line. If this be done there will be no need for any other incision than the vertical one; a transverse division of one or other rectus muscle is then unnecessary, and is at all times most undesirable.

Operation. The abdomen being opened, fluid will escape at once; if the fluid be bile-stained a perforation will probably be found in the duodenum, and it is there that a search should first be made. If the fluid be clear or turbid, containing the remnants of food recently taken, the perforation may be sought in the stomach. This fluid is usually sterile, and is inodorous. The ulcer may be difficult to discover. It may be covered over by adherent masses of thick lymph; to where these are abundant the search should be especially directed. At times the sizzling or the bubbling of gas may lead the surgeon to the point from which the leakage is occurring. The ulcer, as a rule, is found quite readily by searching along the lesser curvature, close to which it usually lies. As soon as it is found I think it best to secure its opening by a single catgut suture taken across it. By this means that constant leakage from the stomach, which is nearly always full, is prevented. My own practice then is to request the anæsthetist to pass the stomach tube, which is ready for use, in order to empty the stomach. This makes the subsequent suturing very much easier; and when the stitches are complete the stomach may be washed out with advantage. The single catgut suture, together with the ulcer, is now infolded by a double layer of stitches of thin Pagenstecher's thread, passed with a fine curved intestinal needle. This infolding and suture may be easy or may be extremely difficult. It is made difficult by the induration and stiffness which surround the ulcer. The hard œdematous margins of the ulcer do not hold the sutures easily. As soon as the stitch is passed it may cut through; or the attempt to bring the edges together may be rendered impossible by the inflexible nature of the stomach-wall at this part. If these difficulties be encountered they can only be overcome either by taking a much wider hold of the stomach, or by covering over the gap in the stomach by a layer of omentum. The former is to be preferred. The stiffness and brittleness, as a rule, do not extend over a large area, and sutures passed wide of this hold firmly enough. A double layer is used, and each layer extends well beyond the ulcer at each extremity. A flap of omentum may then be placed over the suture line and fixed there by one or two interrupted stitches

The toilet of the peritoneum must now receive attention. The views of all surgeons as to how this may best be accomplished do not coincide, and my own practice has from time to time been modified as my experience increased, and as the time which had been allowed to lapse between

from the clamp blades with large straight scissors. The clamps prevent any escape of blood or of stomach contents. The two clamps are now approximated and the suturing begins. A curved needle, which bears either chromic catgut or fine Pagenstecher's thread, is passed on the posterior cut surfaces of the stomach at the part nearest the greater curvature from the mucous surface of the one side through all the coats to the mucosa of the opposite side, and then returns again through all the coats to the mucosa of the lower side, which is pierced about ⅛ inch from the original point of entry. The thread is now knotted, and a continuous suture begun. The needle passes as before from mucosa to serosa of the lower side through serosa to mucosa of the upper side, and then returns from mucosa, through the two apposing layers of serosa, to the mucosa of the lower side. A 'loop on the mucosa' (see p. 336) is thus left at each passage of the stitch. This stitch continues up towards the lesser curvature along the posterior margins of the incision, and then descends along the anterior surface of the stomach from the lesser curvature, to the end of the incision which lies nearest the greater curvature. As soon as this suture is completed it is seen that it has infolded the mucosa, and has secured accurate serous apposition on both anterior and posterior aspects of the stomach. The clamps are then removed, and if any vessel bleeds it is secured by a ligature or by a separate stitch. The whole line of sutures is then reinforced by a continuous Pagenstecher's suture which begins on the posterior surface at the lower end, and continues along the whole line to the end of the suture line on the anterior surface.

The aperture in the gastro-hepatic omentum is then closed, the swabs removed, and the abdomen closed.

If excision of the ulcer in this way should seem impossible, or very difficult, the centre—the 'core', so to speak—of the ulcer may be excised, and the aperture which remains closed by interrupted suture. In this way an artificial perforation is produced and closed. When perforation of an ulcer in this situation occurs we know that its closure results in the permanent relief of the patient in almost every case.

OPERATION FOR PERFORATING ULCER OF THE STOMACH OR DUODENUM

It is in cases of this class that the speed and dexterity which come to the surgeon as the fruit of long practice are of the greatest service. The operation should of course be thorough, and all its details must be observed with the most sedulous care: but the more speedily these things are done the greater is the chance of success. As a general rule the position of the ulcer can be localized to one or other side of the middle line before the operation is begun, and accordingly the incision should

a routine procedure is certainly not necessary, and in some cases—as, for example, when a solitary ulcer near the cardia on the lesser curvature has ruptured—it is quite unnecessary. Inasmuch as it adds appreciably to the length of an operation, every minute of which is of importance, it is then positively dangerous.

After-treatment. The operation being completed, the patient is propped up in bed, and continuous rectal infusion is given. This lessens the thirst of the patient, and also the need for giving much fluid by the mouth for the first thirty-six or forty-eight hours. I allow the patient to drink as soon as the nausea due to the anæsthetic is over.

OPERATION FOR HOUR-GLASS STOMACH

In the condition known as hour-glass stomach there is a division of the stomach into two cavities by a constriction which may be placed at any point between the cardiac and pyloric orifices, but which lies usually closer to the latter. This constriction is always acquired, and is always pathological. It may be due to the cicatricial constriction of a simple ulcer, to compression of the stomach by external adhesions which probably have their origin in an ulcer, or to a new growth.

When the narrowing of the body of the stomach is due to a chronic ulcer, there is not seldom evidence of the existence of a second ulcer at or near the pylorus. This circumstance may add gravely to the surgeon's task in devising an appropriate operation. For the pyloric complement of such a stomach is often dilated, by reason of the obstruction at its outlet. If then gastro-enterostomy be performed between the cardiac pouch and the small intestine, the pyloric pouch remains undrained; if the distal pouch be engaged in the anastomosis, the cardiac pouch is unaffected and the chief disability from which the patient suffered remains unrelieved. It is accordingly sometimes necessary to perform a double operation.

The following operations may be needed :—

1. Gastro-enterostomy : anterior or posterior.
2. Double gastro-enterostomy, a junction of the intestine being made with each sac : Weir and Foote's operation.
3. Double gastro-enterostomy in Y : Monprofit's operation.
4. Gastroplasty.
5. Gastro-gastrostomy.
6. Partial gastrectomy.
7. Stretching of the constriction, as in Loreta's operation.
8. Duodenostomy or jejunostomy.

1. In the majority of cases *gastro-enterostomy between the cardiac pouch and the jejunum* will be the operation of choice. When there

perforation and operation by degrees became curtailed. In most cases a little local wiping is all that is necessary; a hot moist swab is used, and is gently patted on to the parts immediately in the neighbourhood. There should be no rubbing or ungentle handling. The abdomen is then closed without drainage. If there be more extensive soiling of the peritoneum, the process of cleansing must extend further. Hot swabs are passed to one or both kidney pouches, where fluid is prone to trickle and to lodge, or into the iliac fossa or into the pelvis. If there be a general infection of the peritoneum, the whole cavity being full of fluid, and the pelvis overflowing, then anything like a complete cleansing by mechanical means is impossible. I am then content to cleanse, as best I can, hurriedly, with swabs, which are packed away in the abdomen while the suturing of the ulcer is being done. When these are removed, a hand is passed down into the pelvis and a median incision immediately above the pubes is made, and a very large drainage tube is passed to the bottom of the pelvis. I do not practise, nor do I approve of, lavage. It probably does little to cleanse the cavity, and it is not seldom a cause rather than a preventative of shock. Drainage, though rarely necessary, when used should be ample. A split rubber tube in the suprapubic wound may be enough, but other openings may in very late cases be needed to drain the iliac fossæ or kidney pouches. A drain may also be left in the original wound. I find that I have drained only two cases in the last twelve upon which I have operated, and in these two only suprapubic drainage was necessary.

A further and perhaps the most important point is concerned with the necessity of performing gastro-enterostomy at once. When, for example, there has been a perforation of a duodenal ulcer, the infolding and suture will, of necessity, have caused some narrowing of the lumen of the gut. This lessening of the lumen is certain to become worse as time passes and cicatricial contraction occurs in the area of the stomach or duodenum involved in the operation. Again, not a few cases are recorded in which two perforating ulcers have simultaneously, or almost simultaneously, occurred; or in which, after the secure closure of one ulcer, a second has perforated a week or more later, involving death or a second operation. It is a consideration of cases such as these which has drawn attention to the question of the advisability of gastro-enterostomy as an addition to the closure of the rupture in the base of the ulcer. My own practice is to perform gastro-enterostomy when stenosis has been caused at or near the pylorus, or in the isthmus of an hour-glass stomach by the closure of the ulcer; when stenosis is likely to result in the future as a result of the healing of the parts engaged in the operation; or when a second ulcer is present. The performance of gastro-enterostomy as

a routine procedure is certainly not necessary, and in some cases—as, for example, when a solitary ulcer near the cardia on the lesser curvature has ruptured—it is quite unnecessary. Inasmuch as it adds appreciably to the length of an operation, every minute of which is of importance, it is then positively dangerous.

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6. Partial gastrectomy.
7. Stretching of the constriction, as in Loreta's operation.
8. Duodenostomy or jejunostomy.

1. In the majority of cases *gastro-enterostomy between the cardiac pouch and the jejunum* will be the operation of choice. When there

is only the single constriction present, the ulcer which has caused it lies as a rule in the prepyloric portion of the stomach. The cardiac

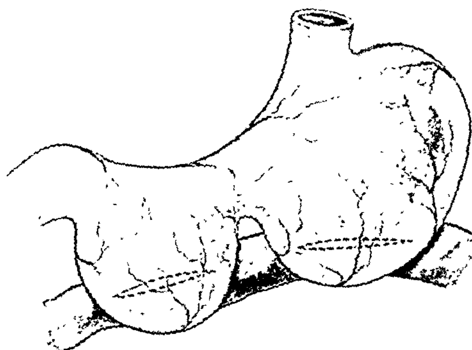


FIG. 128. HOUR-GLASS STOMACH. *Double gastro-enterostomy.*

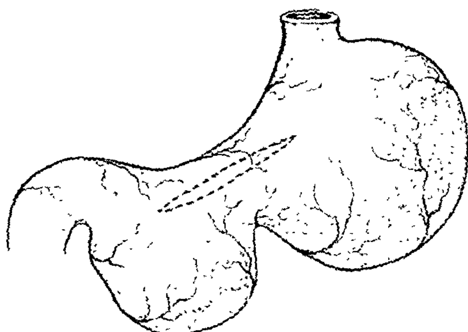


FIG. 129. HOUR-GLASS STOMACH. Gastroplasty.

pouch is therefore very large—larger, indeed, than the *whole stomach* ordinarily is—whereas the pyloric pouch is *not* more than 2 or 3 inches in length, has undergone no dilatation, being unobstructed at its outlet,

and is in no need of direct surgical treatment. The problem then with which the surgeon has to deal is precisely that which confronts him in a case of simple pyloric stenosis, and gastro-enterostomy is the chosen procedure. It is rare to find a difficulty in the performance of the posterior operation, but there may be an adhesion of the stenosing ulcer to the pancreas, with so many surrounding adhesions that the hinder surface

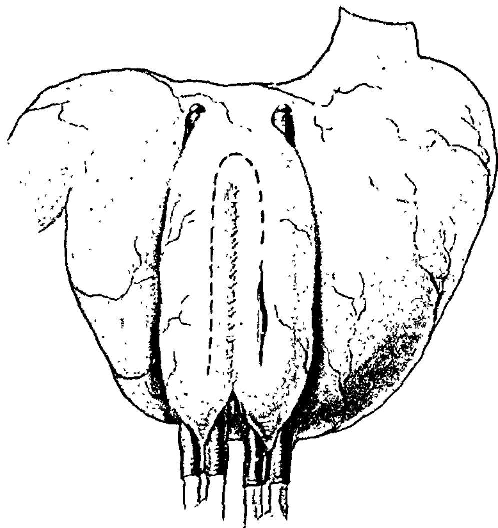


FIG. 130. HOUR-GLASS STOMACH. Kammerer's method of Gastroplasty.

of the stomach cannot easily be reached, and the anterior operation has to be performed. These procedures are carried out in the manner described elsewhere.

2. *Double gastro-enterostomy* Weir and Foote in one case adopted this method. Considering it desirable to endure the emptying of both pouches, they attached the jejunum to each, the two openings in the bowel being near to one another. I have never adopted this method. To perform it, it is necessary that both pouches should be large (they

is only the single constriction present, the ulcer which has caused it lies as a rule in the prepyloric portion of the stomach. The cardiac

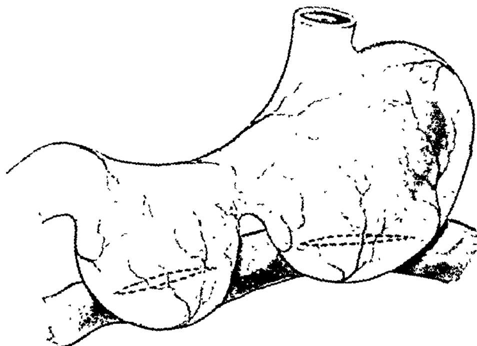


FIG. 128. HOUR-GLASS STOMACH. Double gastro-enterostomy.

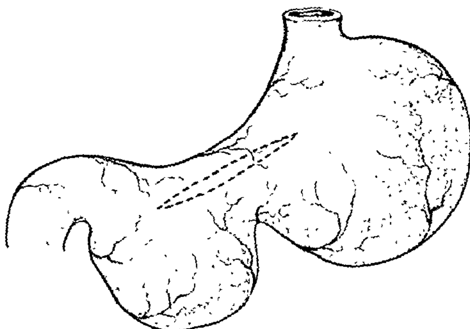


FIG. 129. HOUR-GLASS STOMACH. Gastroplasty.

pouch is therefore very large—larger, indeed, than the whole stomach ordinarily is—whereas the pyloric pouch is not more than 2 or 3 inches in length, has undergone no dilatation, being unobstructed at its outlet,

and that the indications for its performance are more appropriately met by a different procedure.

4. *Gastroplasty.* Gastroplasty is the application to the body of the stomach of a similar procedure to that which is followed in cases of pyloric stenosis in the operation of pyloroplasty. And just as the latter operation, at first sight attractive, has proved in its results extremely unsatisfactory, so with gastroplasty has a secondary operation been too often necessary. A modification of pyloroplasty introduced by Finney, and since known by this name, has given better results. Kammerer has adopted Finney's procedure in a modification of gastroplasty, which converts the operation almost into one of gastro-gastrostomy. The operation is carried out exactly as in Finney's method. Clamps are applied to the two compartments of the stomach close to the isthmus; a sero-muscular suture is applied from the isthmus to the greater curvature; an inverted U or V shaped incision is made in front of this, passing above through the isthmus and laterally down each complement of the stomach to the greater curvature. The inner through-and-through suture is then introduced, and finally the anterior sero-muscular suture is completed. (For details see Finney's operation, p. 350.)

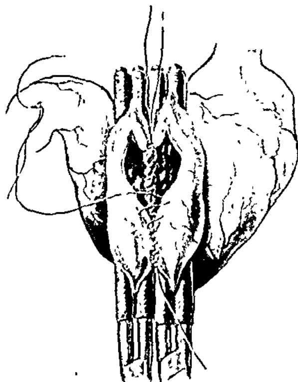


FIG. 132. HOUR-GLASS STOMACH. The inner suture.

5. *Gastro-gastrostomy or gastro-anastomosis*, first suggested by Wolfler, is indicated in those cases in which there is a tight stenosis in the centre of the stomach, with a surface of healthy stomach-wall on each side of it sufficient for a wide anastomosis. There must be no second narrowing in the pylorus or in the duodenum, so that when the obstruction in the body of the stomach has been relieved there is no further impediment to the onward passage of food. This operation in its general lines follows the method already described for gastro-enterostomy. The two pouches are drawn well up into the wound, isolated by large gauze swabs, and seized by a clamp which embraces the whole breadth of the stomach on each side of the constriction from the lesser curvature to

would otherwise not be in need of separate drainage); if they are large, then the operation of gastro-enterostomy would seem to be preferable. There are no indications for this procedure which are not, as I think, better met by other operations.

3. *Monprofit's operation.* This is an application of Roux's method of gastro-enterostomy to hour-glass stomach. The jejunum is divided

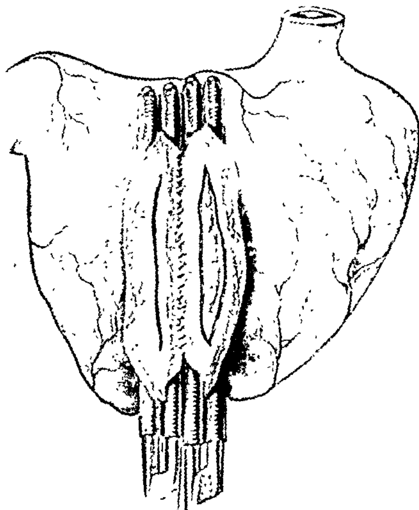


FIG. 131. HOUR-GLASS STOMACH. Gastro-gastrostomy. The clamps applied, one on each pouch.

at a point about 6 inches below the flexure; the distal cut end is attached to the cardiac pouch, and the proximal to the side of the distal about 3 inches below this point; so the cardiac pouch is drained. A second division of the jejunum is made about 10 inches below the first division: the distal end here is attached to the pyloric pouch, and the proximal end again to the side of the distal · in this way the pyloric pouch is drained. The objections to this operation are that it is necessarily tedious and prolonged, four separate anastomoses having to be made,

the greater. The two clamps are then laid side by side, and every detail of the operation carried out as in gastro-enterostomy. When the clamps are removed a few additional stitches are needed to ensure that there shall be no tension on the suture lines.

6. *Partial gastrectomy* is not often necessary in the treatment of hour-glass stomach. The indications are chiefly two: first, in cases of carcinoma of the stomach, a central cylinder being removed and the stomach on each side being then united, or the stomach removed as in the ordinary operation of partial gastrectomy for carcinoma at or near the pylorus; and, secondly, in all those cases in which an indurated mass in the body of the stomach, though almost certainly a chronic ulcer, is yet possibly a malignant growth. The principle upon which to act here is that which Rodman has emphasized when urging his operation of excision of the ulcer-bearing area in multiple ulcers, or in ulcers suspected of malignancy. In a case upon which I recently operated I preferred to remove the greater part of the stomach in the manner described under the title Partial Gastrectomy (see p. 306).

7. *Digital divulsion* can only be very infrequently needed. In one case, however, it served me very well. The case was one of hour-glass stomach with a very large tumour at the isthmus. On opening the abdomen the mass was found to be adherent everywhere, to the abdominal wall in front, and the pancreas behind, so that access to the small cardiac pouch, sheltered under the costal margin, was impossible. Removal of the growth was equally out of the question. I therefore passed one, two, three, and finally four, fingers through the tight constriction from the distal to the cardiac pouch. The patient recovered, and now, several years later, is quite well. The tumour has entirely gone.

8. *Duodenostomy, or jejunostomy,* is only needed in cases of irremovable carcinoma when the cardiac pouch is too small or too inaccessible to permit of an anastomosis being attempted.

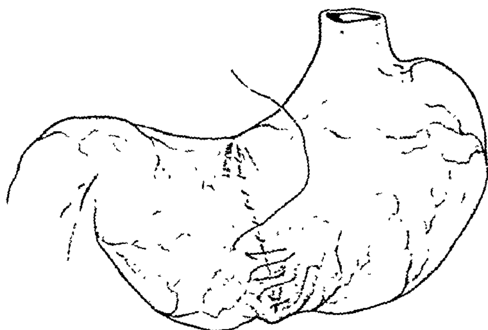


FIG. 133. HOUR-GLASS STOMACH. The outer suture nearly complete.

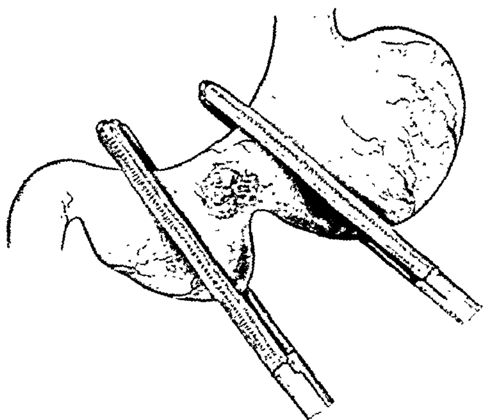


FIG 134. HOUR-GLASS STOMACH. Partial gastrectomy

such as cholecystitis, are offering a mechanical impediment to the proper emptying of the stomach.

(*h*) In those rare cases of obstruction of the pylorus or duodenum due to biliary calculi which have ulcerated through from the gall-bladder (I have operated upon two such cases in which at the first glance the diagnosis of malignant disease seemed irresistible).

(*i*) In certain cases of hour-glass stomach, when the constriction is not far from the pylorus; or when gastroplasty has been performed. In the former the cardiac, in the latter the pyloric, complement is engaged in the anastomosis.

(ii) *In cases of carcinoma of the stomach*, or in the rare cases of cancer of the duodenum, in which the growth is already causing obstruction, or is likely soon to cause obstruction by its increase in size, provided always that the growth cannot safely be removed. The operation may also be performed as a preliminary to gastrectomy in cases where a cancerous growth is still limited to the stomach, but the patient is so wasted and ill that an immediate reaction has every prospect of being fatal. In such cases gastro-enterostomy permits a patient to take a great quantity of fluid nourishment, and very rapidly to gain strength for the more formidable operation which is performed two or three weeks later.

(iii) *In cases of congenital (infantile) hypertrophic stenosis of the pylorus*. In such cases, if any surgical treatment be necessary, and in my judgment it very rarely is so, gastro-enterostomy is to be preferred to all other operations. It is, however, only fair to add that pyloroplasty in the most capable hands of Mr. Clinton Dent has proved very successful.

(iv) *In cases of corrosion of the gastric mucosa* by caustic fluids, acids or alkalies, carbolic acid, nitric acid, soap-lye, or the like. If the pyloric part of the stomach only be affected gastro-enterostomy must be performed, and it may be advantageously combined with temporary gastrostomy.

(v) *In certain cases of acute dilatation of the stomach*, where there is obstruction at or near the pylorus or in the duodenum at the crossing of the superior mesenteric vessels.

Such are briefly the indications for gastro-enterostomy; but it is at least of equal importance to mention the conditions in which the operation must not be performed. In the first place, it cannot be too strongly asserted that this operation must not be done for the relief of symptoms unless there is a demonstrable organic cause for them in the stomach or duodenum. Symptomatic gastro-enterostomy, if one may use the expression, cannot be too strongly condemned. The

CHAPTER IV

GASTRO-ENTEROSTOMY

THE performance of gastro-enterostomy consists in the making of an anastomosis between the stomach and the small intestine. The jejunum is now always selected for attachment to the stomach, and the name 'gastro-jejunostomy' is therefore commonly used for this operation. Two methods of performing the operation are practised: in one the anterior surface of the stomach is engaged in the anastomosis, the operation being described as 'anterior gastro-enterostomy' or 'Wölfler's operation'; in the other the posterior surface is selected, the operation being known as 'posterior gastro-enterostomy' or 'Von Hacker's operation'.

Indications. The following are the indications for this procedure:

(i) *In certain cases of gastric or duodenal ulcer.*

(*a*) In cases of perforating ulcer of the pyloric portion of the stomach, or of the duodenum, when the closure of the perforation causes such narrowing of the outlet of the stomach that it would be difficult or impossible for food to pass.

(*b*) In cases of perforating ulcer of the stomach when other ulcers in or near the pyloric region are disclosed, ulcers which are causing, or are likely to cause as they heal, some hindrance to the free onward passage of food, or are themselves likely to perforate.

(*c*) When perforation has occurred at the isthmus of an hour-glass stomach, and the closure of the perforation has narrowed the passage through the isthmus to a dangerous degree.

(*d*) In cases of hæmorrhage, recurrent and increasing, from either gastric or duodenal chronic ulcers

(*e*) In all cases of chronic ulcer of the prepyloric or pyloric portions of the stomach or of the duodenum If however, as is explained elsewhere, the ulcers are multiple, or are possibly becoming malignant, Rodman's operation of excision of the ulcer-bearing area may be preferable.

(*f*) In cases of fibrous stricture at or near the pylorus, due to a healed ulcer, the symptoms of whose activity have long been in abeyance. The condition in such cases is one of simple pyloric obstruction.

(*g*) In cases of perigastritis or periduodenitis in which the adhesions, due probably to ulcer in the first instance, but possibly to other causes,

cystotomy alone or in addition to gastro-enterostomy. The stomach is then withdrawn from the abdomen, together with the transverse colon and the omentum, which are turned upwards so that the under surface of the transverse mesocolon is exposed. At the same time the duodeno-jejunal flexure and the jejunum at its origin are recognized, and the direction which the jejunum takes is noticed. A thin peritoneal fold usually attaches the first ½ inch of the jejunum to the under surface of

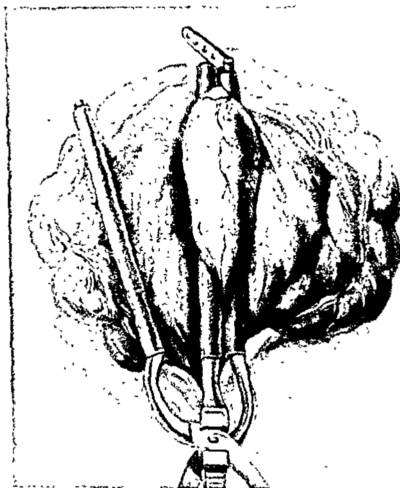


FIG. 135. POSTERIOR GASTRO-ENTEROSTOMY.
Application of the clamp to the stomach.

the mesocolon. At the point where this leaves the mesocolon a pair of forceps is applied and the mesocolon drawn well away, by means of them, from the posterior surface of the stomach. The mesocolon is then incised, or a snip made through it with the scissors, and the lesser sac thus opened. The rent in the mesocolon is then enlarged until it is 3 inches in length. The opening of the lesser sac is not always an easy matter, for there may be adhesions of the upper surface of the mesocolon to the posterior wall of the stomach, or a separation between the layers may be made in the

surgeon will no doubt be asked at times to operate upon patients who suffer much from vomiting, for which an ulcer of the stomach is assumed to be responsible. Unless a definite organic cause can be discovered, a cause fully adequate to evoke the symptoms, this operation must not be practised. The surgeon, moreover, should not be satisfied with a few fine strands of adhesions or a doubtful thickening or roughening of the stomach-wall. If symptoms are caused by a chronic ulcer of the stomach its demonstration calls for no effort of imagination upon the part of the surgeon or the onlookers. The operation is valueless in cases of atonic dilatation of the stomach and in cases of gastroptosis, for both of which it has been warmly recommended, and not seldom performed. It is not in my opinion admissible in either condition. When an ulcer is found upon the lesser curvature near the cardiac end of the stomach excision of the ulcer is preferable to gastro-enterostomy. But excision is not always possible on account of adhesions to the liver or (chiefly) to the pancreas. In such circumstances gastro-enterostomy on the proximal side of the ulcer will be necessary.

POSTERIOR GASTRO-ENTEROSTOMY

The operation of posterior gastro-enterostomy is performed in the following manner :—

The abdomen is opened by a vertical incision 4 to 5 inches in length, about 1 inch to the right of the middle line between the ensiform cartilage and the umbilicus. The anterior sheath of the rectus is opened and the muscle fibres split, or the body of the muscle displaced outwards, and the posterior sheath and the peritoneum then incised together. The outer displacement of the muscle probably leaves a rather firmer abdominal wall when healing is complete, but I have only once seen any weakness of the scar after the separation of the rectus fibres, and that was in a case several years ago, in which Pagenstecher's thread was used to suture the various layers of the abdominal wound, and suppuration subsequently occurred.

The abdomen being opened, an inspection of the whole stomach and of the duodenum and gall-bladder is necessary. This examination must not be omitted, nor may it be only perfunctory. Unless it is carefully observed an hour-glass stomach may be overlooked, as in several recorded cases, or a duodenal ulcer, or old-standing gall-bladder changes due to calculi may escape recognition, and the patient's recovery be thereby seriously prejudiced. The few minutes expended in this investigation are well spent, for if the surgeon has begun the operation in the expectation of performing gastro-enterostomy he may find that other operations are necessary,—gastro-gastrostomy, gastroplasty, gastrectomy, or chole-

The whole of the transverse colon, stomach, and omentum must be pushed backwards into the abdomen through that part of the incision which lies above the clamp; when this is done a large hot flat swab is placed over the wound, coming close up to the clamp, and at each end underlying it a little. Then between the stomach and the jejunal fold as it is pulled up to be grasped by the clamp a long thin strip of hot moist gauze is placed, to lie beneath the centre blade of the clamp so as to catch any possible discharge which may chance to trickle backwards. The jejunum is now clamped. In doing this the gut is pulled up very



FIG. 137. POSTERIOR GASTRO-ENTEROSTOMY.
The viscera clamped and surrounded by gauze.

tightly from the flexure, and care is taken to see that its proximal end is not twisted or kinked. In a few cases the upper end of the jejunum is adherent to the under surface of the mesocolon, or more rarely to the posterior abdominal wall. It chances that I have noticed this condition of mesocolic adhesion more especially in cases of intractable duodenal ulcer. It is worth noting that the adhesion invariably in my experience fixes the jejunum to the right of the flexure. These adhesions must be freed completely up to the flexure before the gut is embraced by the clamp. When it is secured the flange on the top of the upper blade is closed over the middle and lower blades so as to pull the blade-tips well

erroneous belief that the lesser sac has been opened. By seizing the under layer with forceps in the way I have mentioned a clear space is made upon which the incision may fall. Occasionally a vessel may be wounded; if so, it is ligatured at once with very fine catgut. An avascular area is of course chosen for the incision, and any vessel wounded is therefore insignificant in size and quite unimportant.

The stomach is then inspected again from the front, and with the left hand that exact portion of the viscus which it is desired to engage in the anastomosis is pushed from above downwards through the opening in the mesocolon in such manner that the posterior surface can be grasped



FIG. 136. POSTERIOR GASTRO-ENTEROSTOMY.
Application of the clamp to the jejunum.

by the surgeon's right hand and pulled well through, in a bulk sufficient to allow of the easy application of the clamp. A fold is then made upon the stomach from the lesser curvature to the greater along a vertical line. To do this the clamp is applied with the handle on the surgeon's right side, and the tip of the blades pointing towards the patient's head. With the three-bladed clamp, the two upper blades grip the stomach (the uppermost blade bears the loose flange). The clamp is now turned until it lies horizontal and transverse, the handle towards the assistant, the tip of the blades towards the surgeon. The uppermost part of the jejunum is now pulled taut from the duodeno-jejunal flexure in readiness to be clamped by the two lower blades of the three-bladed clamp; but before it is so seized two points must be observed.

and is brought directly along in a straight line until the tip of the blade is reached. It is here that the greater curvature lies, and care is necessary to see that the lowest part of the curvature is engaged in the suture. The large vessels which at this point lie along the curvature and send off their branches to the stomach may readily be avoided. As the suture is introduced it is pulled fairly tight so as to bring the apposing surfaces *snugly together. The part of the thread between the last stitch and the needle when drawn upon raises up a little* hillock on each viscus, showing where the next insertion of the needle is to be made, and making that insertion easier. The number of introductions of the needle is usually

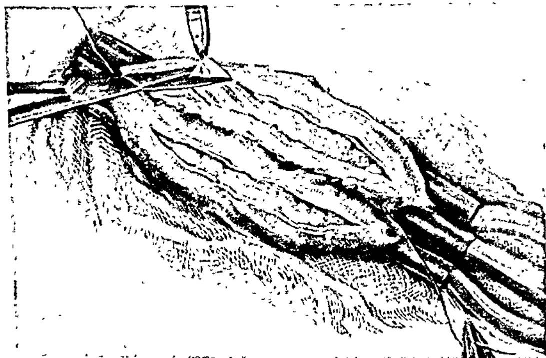


FIG. 139. POSTERIOR GASTRO-ENTEROSTOMY. Excision of the mucosa.

about eight to ten to the inch, and at least 2½ inches should be included in this suture. When this first line is completed the needle is laid aside for a time.

An incision is now made about ¼ inch in front of this suture into both stomach and intestine. The serous and muscular coats only are incised, and the mucous coat then pouts into the wound. An ellipse of this mucosa is then excised from both the stomach and the jejunum ; from the stomach it is removed easily in one piece ; from the jejunum it is almost impossible to take all that is necessary away in one piece, for after removing a large ellipse it is found that a small additional piece at each end requires to be snipped away. The inner suture is *now introduced. It*

together. A second large moist flat swab is placed below the clamp, covering in the lower part of the wound.

All that is now seen outside the abdomen is the clamp, which carries the folds of the stomach and jejunum to be anastomosed, each about 3 to 4 inches in length, closely surrounded in all parts by the substantial gauze swabs. There is, of course, no 'exposure of viscera' throughout this operation, if these steps be properly observed; though it is no uncommon thing to hear this supposed detraction from the merits of the operation discussed. The union of the two viscera is now begun. Two sutures only are used, both continuous. The outer suture is sero-



FIG. 138. POSTERIOR GASTRO-ENTEROSTOMY.
The first line of suture; sero-muscular.

muscular; the inner includes all the coats. The needle I prefer is a curved needle of my own pattern; it is slender, five-eighths of a circle in its curve, has a slot eye, and is of such a diameter that it is the slightest degree thicker than the finest Pagenstecher's thread when doubled. These needles are made by Down Bros. This needle picks up almost automatically the exact amount of the viscera that is necessary, and because of the relationship between its thickness and that of the thread which it carries there is no 'pull' necessary when the thread is to be drawn through the puncture which the needle has already made.

The first suture introduced is a sero-muscular suture. It is begun at the left end of the viscera engaged in the clamp (that nearest the assistant)

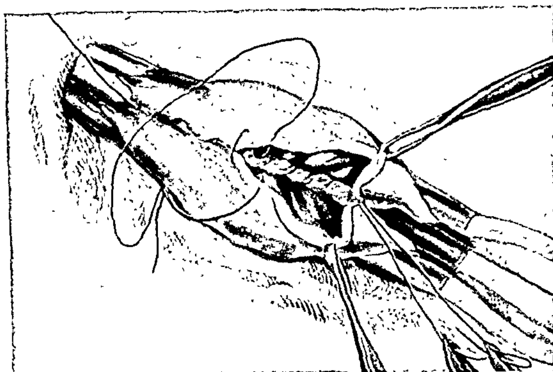


Fig. 142. Posterior Gastro-enterostomy.
The inner suture, showing the loop on the mucosa.

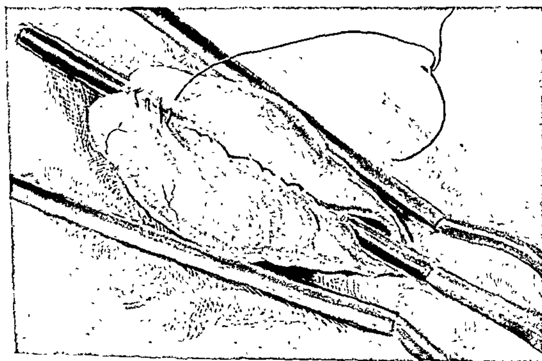


Fig. 143. Posterior Gastro-enterostomy.
The inner suture complete; continuation of outer suture.

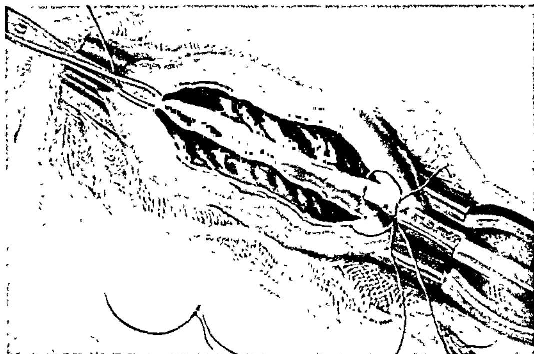


FIG. 140. POSTERIOR GASTRO-ENTEROSTOMY.
The inner suture, through and through, begun.

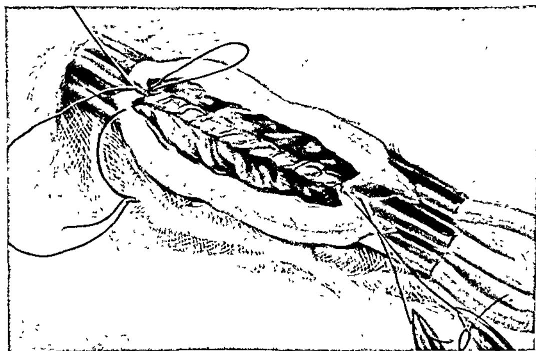


FIG. 141. POSTERIOR GASTRO-ENTEROSTOMY.
The inner suture, turning the corner.

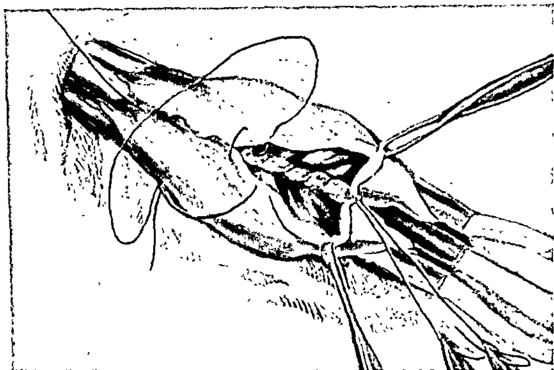


FIG. 142. POSTERIOR GASTRO-ENTEROSTOMY.
The inner suture, showing the loop on the mucosa.

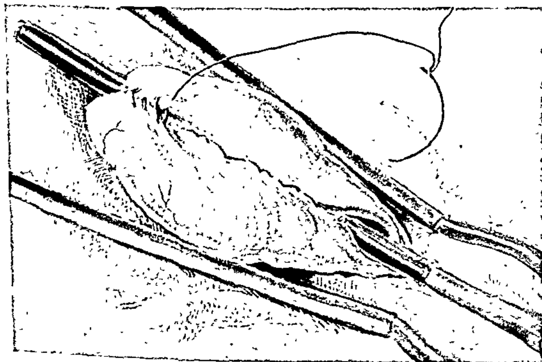


FIG. 143. POSTERIOR GASTRO-ENTEROSTOMY.
The inner suture complete; continuation of outer suture.

embraces all the coats of both viscera, and is hæmostatic. The needle is first introduced through the extreme left end of the jejunum, passing from the mucous to the serous surface; then from the serous to the mucous surface at the extreme left end of the stomach; when the knot is tied it lies therefore upon the mucosa. The stitch is now carried along the posterior (in this position) margins of the opening, passing from mucosa to serosa on the jejunal side and from serosa to mucosa on the stomach side, continuously. It is drawn so tight that any vessel opened by the incision is secured, and the same gentle pull upon the thread



FIG. 144. POSTERIOR GASTRO-ENTEROSTOMY. Removal of gauze strip.



FIG. 145 POSTERIOR GASTRO-ENTEROSTOMY. Attachment of great omentum to suture line.

raising up a fold for the next introduction of the needle will be found of great service.

When the greater curvature of the stomach is reached the type of stitch may well be changed. I now frequently adopt for the return half of the suture line the stitch best described as the 'loop on the mucosa' stitch. It is, I believe, identical with the old 'pillow-maker's stitch'. The change to this stitch is made when the extreme right end of the suture line is reached. The needle at its last passage has penetrated from the mucosa of the jejunum to the mucosa of the stomach, from which the thread now emerges. In the next passage the needle is made to traverse from the stomach mucosa to the serosa. It is now passed through the anterior margin of the jejunum twice, first

from serosa to mucosa, then from mucosa to serosa, so that a 'loop on the mucosa' is left. Then the needle engages the stomach, passing from serous to mucous and from mucous to serous coats at each separate passage of the needle. As the suture is drawn tight, the edges of the incision will be seen to infold themselves so that the serous surfaces come accurately into apposition. This is the prettiest stitch in all surgery; to see the inversion of the two edges occurring as each turn of the suture is tightened is quite pleasing. The suture is continued along the whole

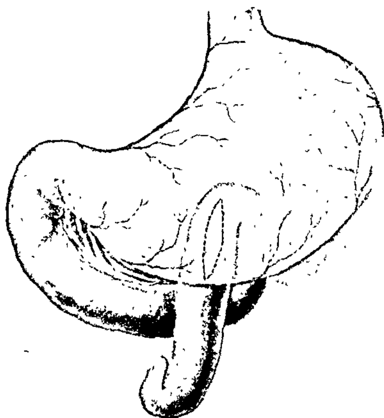


FIG. 146. POSTERIOR GASTRO-ENTEROSTOMY. Completion of the operation.

length of the anterior margins until the original starting-point is reached, and here the needle is made to emerge at the last on the mucosa, and the thread is tied to the end originally left long; the knot therefore lies on the mucous surface. This inner suture may be of thin chromic catgut, or of Pagenstecher's thread; it is immaterial which is chosen.

The parts are now wiped over with a moist swab, and the clamp loosened, the terminal flange being first undone. The clamp is, however, left in position until the final suture is complete. The hands of the surgeon and assistant are thoroughly rinsed, as both have been in contact probably with the mucosa, which, though generally sterile, may be infected. All instruments which have been used up to this stage are discarded and

a clean sterile towel is placed below the wound, upon which the fresh instruments may lie. Before the final suture is introduced the suture line is carefully inspected to see that there are no bleeding points. The needle used for the first suture, temporarily laid aside, is now taken up again, and the sero-muscular suture continued from the greater curvature, which it had just reached, back again, in front of the inner through-and-through suture just completed, to the original starting-point at the lesser curvature. The final turn of the needle at this point is introduced after the original end of the suture, which was left long, has been drawn up in the surgeon's left hand, so that the parts embraced by it are clearly seen.



FIG. 147. POSTERIOR GASTRO-ENTEROSTOMY. Antiperistaltic anastomosis. *Application of clamp.*

The needle is then passed just beyond this first suture, to secure accurate closure at this point, and the suture knotted and cut short.

The parts are again cleaned, the clamp removed, and the strip of gauze which lay behind it pulled out towards the surgeon so that the first line of sutures can be inspected. The next step is to secure the edges of the opening in the mesocolon to the suture line. The transverse colon and omentum are pulled out from the upper part of the wound, wherein they have been lying, and with the surgeon's left hand the transverse colon is lifted away from the abdominal wall until the mesocolon is made taut. An edge of the mesocolon is then seized with a clip and a suture introduced. The needle picks up the mesocolon at some distance from the edge, and then passes through the stomach and jejunum at the line of suture, or through the jejunum alone just as close as possible to the suture line. When this stitch is tightened the roughened cut edge in

the mesocolon is rolled inwards to the lesser sac. Three or four more sutures of the same kind are introduced, all round the opening in the mesocolon, until this peritoneal layer fits closely round the line of anastomosis. The reasons for these sutures are chiefly two: they close the opening into the lesser sac, leaving no gap through which the gut may pass and be strangled, and they ensure a smooth peritoneal fold over all the lines of suture so that no rough edges or tags remain to which adhesions may form. The stomach, colon, omentum, and jejunum are now returned within the abdomen, care being taken to see that the first six or eight inches of the jejunum are directed aright in continuation of the line of anastomosis.

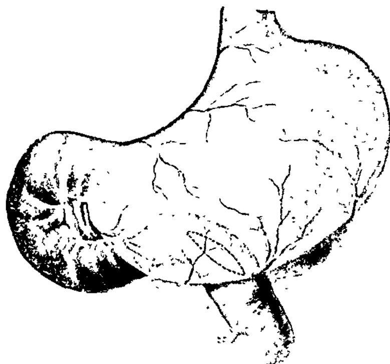


FIG. 148. POSTERIOR GASTRO-ENTEROSTOMY. Antiperistaltic anastomosis. Operation complete.

Mayo's modification of this method consists in making the attachment of the jejunum to the stomach along a line which is oblique from above downwards and to the left. Mayo supposed that this was the 'natural direction' of the jejunum; but I have elsewhere given reasons to show that there is no 'natural' direction of the jejunum at its origin, for it is there free to move to any position in accordance with the position of the body. The vertical position is consequently that most commonly occupied, and it is that which it is best to maintain in the operation of gastro-enterostomy.

The method of applying the clamp and the position of the operation in Mayo's modification are shown in the figures (see Figs. 147, 148); all the other details of the operation are the same as those already described.

Roux's operation. A most ingenious, and in certain cases a most satisfactory, method of performing gastro-enterostomy has been suggested by Professor Roux of Lausanne. It is described as the 'gastro-enterostomy in Y'. The intention of the operation is to reproduce

a clean sterile towel is placed below the wound, upon which the fresh instruments may lie. Before the final suture is introduced the suture line is carefully inspected to see that there are no bleeding points. The needle used for the first suture, temporarily laid aside, is now taken up again, and the sero-muscular suture continued from the greater curvature, which it had just reached, back again, in front of the inner through-and-through suture just completed, to the original starting-point at the lesser curvature. The final turn of the needle at this point is introduced after the original end of the suture, which was left long, has been drawn up in the surgeon's left hand, so that the parts embraced by it are clearly seen.

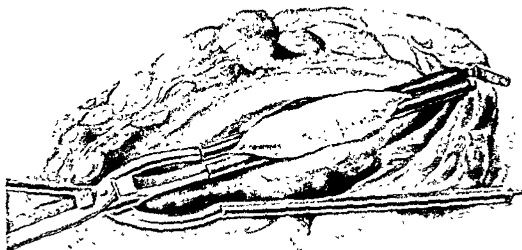


FIG. 147. POSTERIOR GASTRO-ENTEROSTOMY. Antiperistaltic anastomosis. Application of clamp.

The needle is then passed just beyond this first suture, to secure accurate closure at this point, and the suture knotted and cut short.

The parts are again cleaned, the clamp removed, and the strip of gauze which lay behind it pulled out towards the surgeon so that the first line of sutures can be inspected. The next step is to secure the edges of the opening in the mesocolon to the suture line. The transverse colon and omentum are pulled out from the upper part of the wound, wherein they have been lying, and with the surgeon's left hand the transverse colon is lifted away from the abdominal wall until the mesocolon is made taut. An edge of the mesocolon is then seized with a clip and a suture introduced. The needle picks up the mesocolon at some distance from the edge, and then passes through the stomach and jejunum at the line of suture, or through the jejunum alone just as close as possible to the suture line. When this stitch is tightened the roughened cut edge in

ANTERIOR GASTRO-ENTEROSTOMY

The abdomen is opened by an incision through the right rectus muscle, as in the former method, and the stomach examined in all its parts. The decision to perform anterior gastro-enterostomy having been made, the transverse colon and the omentum are drawn out of the lower part of



FIG. 150. POSTERIOR GASTRO-ENTEROSTOMY. Roux's operation completed.

the wound, and are displaced upwards sufficiently to allow the discovery of the uppermost part of the jejunum as it comes off from the duodeno-jejunal flexure. The jejunum is lifted into the wound, and passed through the fingers until a point on it about 16 to 18 inches from the flexure is reached. This is the part which is to be engaged in the anastomosis. A clamp is now applied, embracing about 3 to 4 inches of the gut at this part, the proximal end being to the left, the distal to the

artificially at the new anastomosis the conditions which exist at the pylorus. To give effect to this, the jejunum is divided at a spot about 10 or 12 inches below the duodeno-jejunal flexure; the distal end is implanted into the stomach (making a new pylorus), the proximal end is attached to the side of the distal 3 to 4 inches below the junction with the stomach (making a new diverticulum of Vater). The anastomosis with the stomach is made on the posterior surface close to the lowest point of the greater curvature. The following is the method of procedure: The posterior surface of the stomach is exposed and clamped as in the usual posterior operation. The jejunum is then brought up into the wound, and a point on it about 10 inches below the flexure is selected as the apex of a loop about 8 inches in length, the base of which is gripped with a clamp. This loop, being securely held, is now divided at about 2 inches below the upper clamped extremity. The division continues a little way into the mesentery so as to allow the distal limb to be drawn away from the proximal. The distal opening is now united by suture to that portion of the stomach-wall which is gripped by the clamp. Two layers of suture only are necessary, and they are passed in exactly the same manner as in the procedure already described; Roux himself, however, uses three layers of stitches. This anastomosis being completed, the divided proximal end of the jejunum is now united to the side of the distal limb about 3 inches below the stomach. The opening in the transverse mesocolon is then closed by suture to the stomach around the anastomosis and the operation is complete.

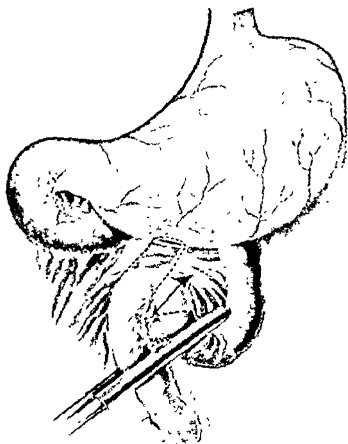


FIG. 149. POSTERIOR GASTRO-ENTEROSTOMY. Roux's operation. Application of clamp, division of gut.

of suture. Another point worthy of attention is this: the opening in the jejunum should lie not at the part exactly opposite the line of mesenteric attachment, but rather on that side of the gut which lies nearest the stomach, in such manner as to secure that the lateral aspect of the bowel lies flat against the anterior surface of the stomach.

The suture being completed the clamps are withdrawn. One or more additional suspension sutures may be placed between the stomach and jejunum at the upper end, if thought desirable. When the viscera are replaced within the abdomen, care should be taken to see that the transverse colon and the omentum are well placed, and that the proximal limb of the jejunum does not seem to constrict the transverse colon.



Fig. 152. Anterior Gastro-enterostomy. Complete.

If it be thought desirable to perform an entero-anastomosis between the afferent and efferent limbs of the jejunum, this may readily be done about 3 inches below the stomach. The two jejunal lengths to be united are embraced by clamps, isolated by gauze swabs, and united by suture in exactly the same manner as has been already observed in the making of the union between the stomach and the bowel.

COMPLICATIONS AND SEQUELÆ OF THE OPERATION

The experience of the last decade has shown that the operation of gastro-enterostomy, however brilliant its immediate results, is not free from certain risks, which, though perhaps tardy in appearance, are yet directly attributable to the operation. It is true that the majority of these complications are now abolished, or have had their frequency much lessened by recent improvements in technical details; but their consideration here is none the less incumbent upon me.

right, that is, towards the operator. A similar clamp is now applied to the stomach, in such a manner that the portion of the anterior wall of the viscus which is grasped lies obliquely from above downwards and to the right. The lowest part of the fold lying in the blades must be that point on the greater curvature of the stomach which lies vertically below the right margin of the œsophagus; it is the lowest point of the greater curvature. The two clamps being applied, all the viscera not grasped by them are returned within the abdomen. A long thick gauze strip is now laid between the clamps, which are brought together, and around

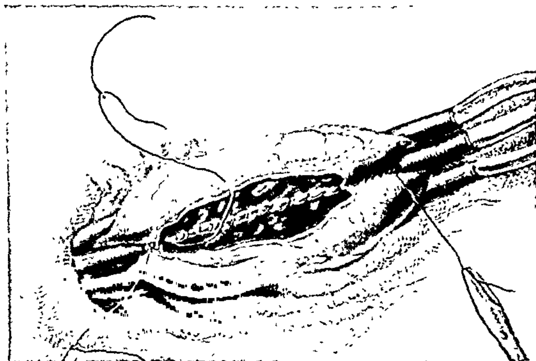


FIG. 151. ANTERIOR GASTRO-ENTEROSTOMY. *Clamp applied.*

them are laid flat gauze swabs wrung out of hot saline solution. Nothing, therefore, can now be seen except the clamps, the parts of the viscera they hold, and the flat swabs which fit closely round them.

The union of the two viscera is now begun, and the exact details which are given in the description of the operation of posterior gastro-enterostomy are followed, with a slight exception. When the first line of sutures has been introduced, the incision in the stomach and the intestine is not made to the full extent of this, but lies along only the lower two-thirds of the line. The result is that when the suturing is complete the outer suture extends upwards along the stomach and jejunum for some distance beyond the opening which connects them. There is a suspension therefore of the jejunum above the anastomosis, the suspension being caused by the upper extremities of the outer line

of suture. Another point worthy of attention is this: the opening in the jejunum should lie not at the part exactly opposite the line of mesenteric attachment, but rather on that side of the gut which lies nearest the stomach, in such manner as to secure that the lateral aspect of the bowel lies flat against the anterior surface of the stomach.

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Fig. 152. Anterior Gastro-enterostomy. Complete.

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COMPLICATIONS AND SEQUELÆ OF THE OPERATION

The experience of the last decade has shown that the operation of gastro-enterostomy, however brilliant its immediate results, is not free from certain risks, which, though perhaps tardy in appearance, are yet directly attributable to the operation. It is true that the majority of these complications are now abolished, or have had their frequency much lessened by recent improvements in technical details; but their consideration here is none the less incumbent upon me.

Hæmorrhage. The occurrence of bleeding after the operation of gastro-enterostomy may be of every grade of severity. If a patient vomits at all after this operation, a very unusual circumstance in my own experience, the ejected matter is almost always just tinged with altered blood. This blood has probably escaped into the stomach at the time the anastomosis was made, and in quantity it is not more than one or two teaspoonfuls. But there are cases in which the hæmorrhage may be considerable, and at least three cases have been reported in which it has proved fatal. The blood may come from two sources: from the ulcer or ulcers for which the operation has been performed, or from the incisions made into the stomach or jejunum at the line of anastomosis. It is only rarely that the ulcer is the source, but the fact that it sometimes is so should compel the surgeon to exercise great gentleness in handling the ulcer itself, or the part of the stomach or duodenum in which it lies. Furthermore, the policy of infolding all ulcers of the duodenum or of the pyloric portion of the stomach, which I have so long advocated, should be adopted, for thereby the vessels going to the ulcer are carefully secured, and the risks both of perforation and of hæmorrhage are annulled. The hæmorrhage may occur also from the suture line, and it is probable that it does so in the majority of cases. I have had two cases in which fresh blood, to the quantity of about one pint, was vomited within twenty-four hours of the operation; in both the hæmorrhage came, no doubt, from the incision in the stomach, for in both the ulcers were small, and had never bled before. These two cases were in my early experience; since I learnt to suture better I have had no cases of hæmorrhage, for the securing of all vessels by a well-applied stitch will effectually prevent even the slightest risk of bleeding. This untoward complication may therefore be avoided by the handling of all parts during the operation with the most sedulous care, and by so applying the inner suture that all vessels are well secured.

When hæmorrhage occurs in any quantity it is desirable at once to cease giving fluids by the mouth, except perhaps adrenalin (30 minims of 1 in 1,000 solution in a dessert-spoonful of water every half-hour, or every hour, till six or eight doses have been taken); lavage of the stomach with water as hot as can be comfortably borne is sometimes useful.

Regurgitant vomiting. No small part of the literature dealing with operations upon the stomach is concerned with this question of regurgitant vomiting. The 'vicious circle' has proved the most terrible and the most frequent of the serious complications of gastro-enterostomy. I well remember that of the first thirteen cases of gastro-enterostomy that I saw as a resident officer, no fewer than nine died as a result of regurgitant vomiting. Vomiting comes on as a rule within the first few hours or days of the operation. In quantity the ejected matters vary

considerably, but in the severer cases two or three pints are vomited every twenty-four hours. The ejected matters are bile-stained; in some cases they consist of pure bile, in others the colour may be brownish and the odour offensive. As a rule, the act of vomiting is painless, a great gush of fluid pours from the mouth, with little or no straining on the part of the patient.

Regurgitant vomiting is due to high intestinal obstruction. The obstruction may be at the anastomosis, either afferent or efferent opening being implicated; or it may involve the jejunum a few inches below the anastomosis. As a rule, the obstruction is at the afferent opening, and is probably due to the fixation of a piece of intestine, weakened by the division of its circular muscular coat, in such conditions that a loop remains between the duodeno-jejunal flexure (a fixed point) and the anastomosis. As a result of a kink at the weakened spot the loop becomes 'waterlogged'; it is found greatly distended and overfull when the abdomen is opened. Relief is afforded by entero-anastomosis, by the union of the engorged loop to the empty and collapsed intestine distal to the obstruction. The efferent opening also may be obstructed by kinking, or the jejunum may be compressed by adhesions immediately beyond its attachment to the stomach. Regurgitant vomiting is avoided by adopting the posterior no-loop operation. Nevertheless, in some cases after this method has been practised there may be vomiting of bile, irregularly and painlessly. This condition may appear weeks or months after the operation; it is distressing and troublesome, but not a serious menace to health. It is almost certainly due to some slight obstruction at the duodeno-jejunal flexure or at the upper end of the anastomosis to the stomach, the result of an improper application of the intestine rotated around its axis; or to the selection of a piece of intestine an inch or more too low down on the jejunum, so that a very short loop is left which may kink either at the upper or at the lower end. When vomiting of this kind occurs, recourse should quickly be had to lavage of the stomach. It is remarkable how effectual this may be in lessening or even in entirely abolishing this most distressing symptom. If the stomach be emptied and washed out once or twice daily, the vomiting may disappear, never to return. If, however, in spite of lavage, regurgitation still continues, then the abdomen must be reopened and the mechanical defect, which is generally easily recognizable, repaired at once. Entero-anastomosis between the proximal and distal jejunal limbs, or the division of the afferent limb and the performance of Roux's gastro-enterostomy in Y at another part of the stomach, will usually be indicated.

Jejunal ulcer. The occurrence of this, perhaps the most serious, certainly the most interesting, complication of gastro-enterostomy was

first observed by Braun, and recorded in 1889. Since then some forty cases have been related.

The ulcer is found in the jejunum bordering on, or within a short distance (usually within 1 inch) of the opening from, the stomach. As a rule, it is solitary, but two, three, or in one case four, ulcers have been found. The investigation of the recorded cases has shown me that four types of this disease may be recognized.

(*a*) The ulcer develops rapidly and perforates shortly after the operation. There are only three cases which can be included in this group. The circumstances in all are similar: gastro-enterostomy was performed for an ulcer at or beyond the pylorus, associated with hyperacidity, which in two cases was intense; the progress for the first few days was satisfactory, then suddenly there was an acute onset of pain followed by peritonitis and death. In all cases an ulcer just beyond the anastomosis was found, and perforation had occurred into the general peritoneal cavity.

(*b*) The ulcer develops within a few weeks or months of the operation, and the symptoms suggest a recurrence of the ulcer for which the operation was performed. The cases in this group are many. The symptoms are very similar to those which were caused by the original ulcer, in the stomach or in the duodenum, for which the gastro-enterostomy was performed. These complaints are attributed to a supposed 'recurrence' of the ulcer. Secondary operations were performed for disabling symptoms or for perforation and peritonitis. In these instances acute perforation had occurred in a chronic ulcer.

(*c*) The ulcer develops languidly, and insidiously undergoes a 'subacute' perforation, with the result that a tumour forms in, or abutting upon, the epigastrium. About two-fifths of all the recorded examples fall in this category. There are not usually any symptoms of which the patient takes serious notice. As a rule only some trivial discomfort after meals or indigestion is noticed; on examination of the patient a distinct tumour is felt. When the abdomen is opened the jejunum at or near the anastomosis is found adherent usually to the parietes. On separating the viscera a perforation into the intestine at the site of an ulcer a little below the anastomosis is discovered. The condition, it will be seen, is precisely analogous to that of 'subacute perforation' in the stomach (see *Annals of Surgery*, 1907, vol. xlv, p. 223).

(*d*) The ulcer perforates into a hollow viscus. The ulcer is of the chronic type, and perforation occurs after adhesion to a hollow viscus, either the stomach or the colon.

A careful examination of all recorded cases has shown that jejunal

ulcer occurs only after operation for simple ulcer of the stomach or duodenum. I have found no instance in which the operation was performed for cancer. This absence of jejunal ulcer in malignant cases may be due to the short duration of life after operation—the patient has not time, as it were, to develop an ulcer; or it may be due to the absence in most cases of free HCl from the gastric juice. Peptic ulcer has occurred more often after the anterior operation than after the posterior, though probably the latter has been, and now certainly is, far more frequently performed for non-malignant conditions. All forms of gastro-enterostomy have, however, furnished examples; the anterior and the posterior with or without entero-anastomosis, Roux's operation and the no-loop method. More cases have occurred in men, and in most instances free HCl has been found in excess.

The fact that peptic jejunal ulcer may occur after gastro-enterostomy should urge the surgeon to see that the greatest care is exercised by the patient in the matter of diet for several months after operation. In a patient who for years has been unable or unwilling to take food, the swift return after operation to health and a good appetite which can without discomfort be appeased, leads not seldom to over-indulgence in both food and drink. It is probable that the same conditions are being repeated which were responsible for the development of the original ulcer in the stomach. It is most desirable that all patients who have been submitted to operation upon the stomach should report, or present themselves, to their medical men for some months after operation.

Intestinal obstruction. Several cases of intestinal obstruction following gastro-enterostomy are recorded. As I have mentioned, regurgitant vomiting is due to obstruction of the jejunum very high up, close to or at the anastomosis. Several other forms are described. I have myself lost a patient from an internal hernia, the small intestine having passed through the opening made in the transverse mesocolon into the lesser sac, and having become obstructed by the margins of this opening. This accident may be prevented by closure of the opening, its margins being sutured to the stomach, jejunum, or suture-line, after the anastomosis is complete. Other cases have shown obstruction of a length of gut which has passed through a loop left between the duodeno-jejunal flexure and the anastomosis. This loop, together with the mesocolon, forms a ring, and through this ring intestine has passed from right to left in some cases, from left to right in others, to become strangulated; in one case a volvulus of the bowel was also found (Barker). In anterior gastro-enterostomy the loop of jejunum, if pulled too tight (by selection for the anastomosis of a part too near the flexure), may constrict the

colon. One case of obstruction due to the adhesion of a piece of small intestine to the abdominal incision is also recorded (Newbolt, *Lancet*, 1907, ii. 1461).

Diarrhœa. In some few cases diarrhœa after operation has been observed; as a rule it is transient and easily relieved; in some cases, however, it has been continuous and uncontrollable and has caused the patient's death. Kelling has described two forms. Firstly, that in which the diarrhœa is due to the escape into the intestine of acid contents which are not neutralized by the bile or pancreatic juice. Secondly, that in which it is due to 'fermentation'. The latter he considers is not serious, and is seen only in patients suffering from carcinoma, or in those cases where HCl is deficient or absent. There is no convincing evidence of the existence of the first form. Indeed, a survey of one's own experience and of the recorded evidence available has shown that it is almost exclusively in cases of carcinoma that diarrhœa occurs, and that it is only in them that it is at all serious. The motions are always offensive. Anschütz believes that the chief cause is the extreme exhaustion of the patient, by a long-standing disease, at the time the operation is performed; and he remarks that exactly the same type of intestinal uncontrol is found when there is carcinoma or advanced tuberculous disease in other parts than the intestine.

There is, however, no acceptable explanation which is applicable to all cases. So far as treatment is concerned we must attend to the diet, giving only sterile foods (not necessarily fluid) and administering antiseptics (isoform preferably), magnesia usta, and opium or other astringents in large doses.

THE RELATIVE MERITS OF ANTERIOR AND POSTERIOR GASTRO-ENTEROSTOMY

The gradual transference of the allegiance of the surgeons of largest experience from the anterior to the posterior operation is not due to mere caprice, but to a confident belief that the latter operation, both in its immediate and remote results, is the better procedure. The points which are to be discussed in this connexion are concerned with—

(*a*) Regurgitant vomiting.
(*b*) Peptic jejunal ulcer.
(*c*) Intestinal obstruction due to internal hernia.

Regurgitant vomiting. The causes of this most disastrous complication are elsewhere discussed. It is only necessary here to say that it is an evidence of intestinal obstruction occurring at or near the anastomosis. It occurs far more commonly after the anterior than after the posterior operation; indeed in many of the early cases of the former

method it was the direct cause of death. It is now recognized that it is the existence of the 'loop' which is responsible for the onset of this symptom. The jejunum, attached normally at the duodeno-jejunal flexure, and fixed by suture to the stomach at a point 15 or 18 inches lower down, forms a loop, which is apt to become 'waterlogged'. At the point where the anastomosis to the stomach occurs, not only is there an abnormal fixed point, but the gut at this part is weakened by the division of circular muscular fibres in its wall. That the obstruction occurs at the anastomosis (either afferent or efferent opening being blocked) is shown by the fact that relief from the vomiting is promptly ensured when the limbs of the bowel are united by the performance of entero-anastomosis. The 'loop' is the responsible factor. If posterior gastro-enterostomy is performed with a loop, regurgitant vomiting is as likely to occur as after the anterior operation. It is in the abolition of the loop, by performing the anastomosis close to the flexure, that safety lies. The posterior operation, therefore, is better than the anterior, not merely because it is posterior, but because, being posterior, it allows the jejunum close to the flexure to be engaged in this anastomosis, and the loop, consequently, to be eliminated.

Peptic ulcer. This condition has only been found to occur after operations for non-malignant diseases ; it has never followed upon gastro-enterostomy for carcinoma. The number of recorded cases shows that the ulcer is found more frequently after the anterior operation than after the posterior ; perhaps because the lower opening into the bowel exposes a mucosa which is more sensitive to acid contact.

Internal hernia. Several forms of internal hernia are recorded. In the posterior operation it may be caused by the escape of the small intestine upwards into the lesser sac, through the opening into the transverse mesocolon. I have myself lost one case through this accident. The attachment of the mesocolon by a few stitches to the stomach, or to the stomach and jejunum along the line of suture, will, however, close the aperture into the lesser sac and prevent the occurrence of this form of hernia.

In the anterior operation two forms of obstruction have occurred. In one the loop of jejunum, being drawn up tightly from the flexure to the stomach, has constricted the transverse colon and occasioned an obstruction sufficiently severe to prove fatal. In the other loops of the small intestine have passed from right to left, or from left to right through the ring formed by the under surface of the transverse mesocolon and the jejunal loop as it passes from the flexure to the anastomosis, and have become strangulated. In both cases it is the loop of jejunum which is the factor responsible.

Taking these points into consideration there can, I think, be no doubt that the posterior no-loop operation is that which is, on all counts, the most satisfactory. It is sometimes argued that the posterior operation is not so suitable in many cases as the anterior method, on account of its difficulty and because of the necessary 'handling' and 'exposure' of the viscera. Those who argue thus have but little experience of the posterior operation, or employ a technique which is not satisfactory. *The one operation is as easy as the other ; there is very little handling of* the viscera in either case, and nothing more than a momentary and quite harmless exposure. I have a considerable experience of both operations, having performed the posterior operation over five hundred times and the anterior over seventy times. The results in the immediate after-history of the two operations differ sensibly. After the posterior operation the patient is at once quite well. He has no sickness, no feeling of nausea, is comfortable, and is soon eager for food. After the anterior operation there is sometimes a feeling of nausea, occasionally a little vomiting, and appetite returns less rapidly. We should, however, consider the results of the anterior method decidedly good (as indeed they are) were it not that they suffer by comparison with those achieved by the posterior operation.

GASTRO-DUODENOSTOMY (FINNEY'S OPERATION)

The operation of gastro-duodenostomy was introduced into surgery by Jaboulay, who first performed it in 1894. He made two incisions of equal length, one in the stomach, the other in the duodenum, and united these by suture, the pylorus being displaced backwards, as it were, to allow of the approximation of the two openings in front of it. Kummell adopted a different method ; he divided the duodenum completely across and implanted the distal end into the anterior wall of the stomach after closure of the proximal end. The operation of pyloroplasty suggested by Heinecke and Mikulicz consisted in dividing the pylorus transversely, in cases where an ulcer has caused cicatricial stenosis, the wound then being sutured in a vertical direction. The results of this operation at the first were very remarkable, but the lapse of months or of years did not bear out the early promise. Patients who had for a time enjoyed perfect health and normal appetites began to have a recurrence of their former symptoms, and many of them submitted willingly enough to the operation of gastro-enterostomy in order to obtain relief from their renewed sufferings. Pyloroplasty, indeed, fell very properly into disuse. Dr. J. M. T. Finney of Baltimore introduced what he termed a 'modified form of pyloroplasty', to which the names of 'gastro-duodenostomy' and

'gastro-pyloro-duodenostomy' have been given. The simplest and most generally accepted title is 'Finney's operation', which is thus performed :—

The abdomen is opened by an incision to the right of the middle line, as in gastro-enterostomy. The pyloric region of the stomach is exposed and examined. Adhesions which at first sight would appear to negative any plastic procedure being performed will yield readily to careful and persistent stripping with gauze. The free division of all tethering adhesions is the first and perhaps the most important of all the steps in the operation. The second portion of the duodenum is well stripped upwards by incising, as Kocher directs, the peritoneum along the outer side of the gut, and working the fingers in towards the middle line on the inner side of the incision until the duodenum is rendered movable and can be lifted upwards and forwards into the abdominal wound. The pyloric part of the stomach, the pylorus and the first and second parts of the duodenum—the parts, in fact, which are to be engaged in the operation—being thus made free, are then carefully surrounded by hot moist swabs, which isolate them from the rest of the peritoneal cavity. The purpose of the operation is now to anastomose the stomach to the duodenum, and to this end clamps are applied to each, gripping those portions of the

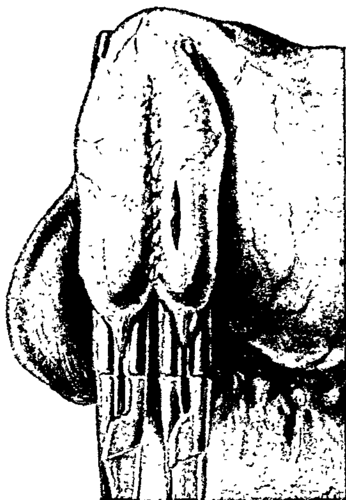


FIG. 153. FINNEY'S OPERATION.
The first suture; the stomach opened.

viscera in which the openings are to be made. The clamps are then laid side by side and surrounded with gauze. At the tip of each there is a portion of the stomach and of the duodenum which is not embraced, as will be seen by reference to Fig. 153.



Fig. 154. Finney's Operation.
Showing new disposition of the parts.

The sutures are now introduced. They are of the same material, and are similarly applied, as in the operation of gastro-enterostomy. A double layer is used, as in that case—an outer sero-muscular, and an inner which embraces all the coats. When the first sero-muscular suture has been introduced, the viscera are opened by two incisions, which are continued into one another at the upper extremity, so that a single inverted U-shaped incision is made, instead of two separate incisions, as in gastro-enterostomy. The details of the operation do not differ further from those already described in the chapter dealing with that operation.

I have rarely used Finney's operation, believing that the indications which are held to call for its performance are better met by the operation of gastro-enterostomy.

CHAPTER V

GASTROPEXY

Gastropexy is the operation by which a stomach, which is prolapsed, is brought up into its normal position and there fixed by sutures which engage either the stomach or its upper or lower omental attachments.

Indications. The value of the operation, or rather the need for its performance, is very differently estimated by various surgeons. There are some, Rovsing for example, who consider that the falling downward of the stomach is by no means an infrequent event, that the displacement is attended by symptoms of such severity or of such persistence that its repair by operation is not seldom necessary. There are other surgeons, of whom I count myself one, who do not attach much importance to this one deformity, but consider it rather as a part, and by no means always the most important part, of a more widespread disorder; they consider accordingly that operative treatment of the condition is rarely necessary.

Rovsing (*Trans. Int. Soc. de Chir.*, i. 338) recognizes two forms of gastroptosis. In the first and less common form, which he describes as 'virginal', the descent occurs in young women who have not borne children, and in whom, therefore, the abdominal wall is firm and strong. The second form occurs in multiparous women with lax and perhaps pendulous abdominal walls; the prolapse of the stomach is associated with a general descent of all the viscera. In the former type operative treatment is indicated; there is no fault in the abdominal wall and the pressure of a belt does little or nothing to help the muscular support, which is neither weak nor insufficient. In the latter type a well-fitting belt, whose greatest pressure is below (this is effected by means of a triangular air-pad, the base being at the pubes and the apex above the umbilicus), will suffice to give that support to the stomach and to the other viscera, of which they have been deprived by the relaxation of the abdominal wall. Rovsing, in his last report, gave details of forty-nine cases upon which he had operated. Forty-four of these were of the virginal type, five of the multiparous. In six of the cases stasis of the stomach contents was noticed. The results of the operations were very satisfactory; there were no deaths; the only patient who was not relieved was one in whom, at a second operation, duodenal ulceration and adhesions, which had

previously escaped notice, were discovered. In two cases displacement of the liver was also found.

Operation. The surgical treatment of gastroptosis was first advocated by Duret of Lille.

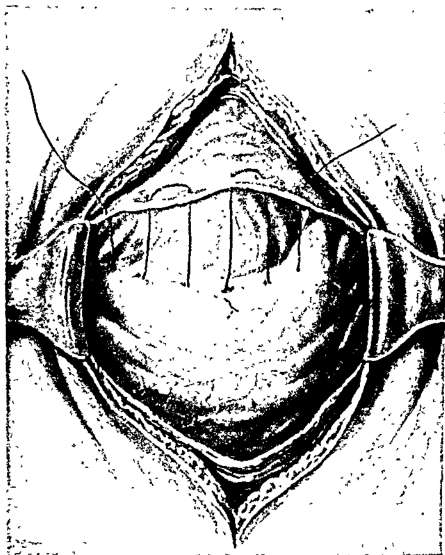


FIG. 155. GASTROPEXY Duret's method.

Duret's operation The abdominal wall is incised from the ensiform cartilage to the umbilicus until in the whole length of the wound the posterior sheath of the rectus and the peritoneum are exposed. These layers are incised only for a short distance at the lower end; the fingers introduced through this opening into the peritoneal cavity manipulate the stomach during the subsequent stages of the operation. The purpose of the steps which follow is to replace the stomach and to fix it by suture against the layer of undivided peritoneum in the upper part of the wound.

A continuous suture of silk was used by Duret, but probably a strand of chromic catgut or of kangaroo-tendon would be preferable. The recti muscles are separated as widely as possible at the upper part of the incision. Through the edge of the left rectus muscle the needle passes from before backwards into the abdomen, where it is seized by the fingers of the left hand passed upwards through the lower part of the incision. The needle is then passed horizontally through the stomach-walls close to the lesser curvature, at its left extremity. The needle then returns from behind forward through the undivided peritoneum in the upper end of the abdominal wound, being brought out about three-quarters of an inch from the point of its original introduction. The stitch therefore forms up to this point a single mattress suture. The needle is now passed in a similar manner several times into the abdomen to engage the stomach, and out again through the peritoneum. The last stitch comes out through the edge of the right rectus muscle. When the whole length of the thread is tightened the lesser curvature of the stomach is drawn into intimate approximation with the anterior abdominal wall.

The first patient upon whom Duret operated was a married woman who had suffered acutely for three years. The result of the operation was perfectly satisfactory; the patient was completely relieved of all her symptoms and gained 25 lb. in three years.

Beyea's operation. This is, in my opinion, the most satisfactory of all the methods; in six cases I have adopted it either alone, or, when organic disease of the stomach has been present, in addition to gastro-enterostomy, and I have been satisfied that the principles and the details of the operation are sound. I prefer to give Dr. Beyea's own description of the operation (*Phil. Med. Journ.*, 1903, i. 257):—

'An incision about three inches in length was made through the linea alba, midway between the xiphoid cartilage and umbilicus. The tissues were separated in the usual manner, and the peritoneal cavity opened, exposing a small portion of the lesser curvature and cardiac end of the stomach, the gastro-hepatic ligament or omentum, gastro-phrenic ligament, and the lower portion of the left lobe of the liver. The table was then elevated to the Trendelenburg position, and the stomach displaced still further downward and out of the wound by means of gauze sponges. This procedure caused the gastro-hepatic and gastro-phrenic ligaments to be slightly stretched and separated from the underlying structures, which permitted an accurate determination of the length of these ligaments and very much facilitated operative manipulations. The gastro-phrenic ligament was seen well developed, and evidently formed a strong support to the cardiac end of the stomach. The adjoining portion of the gastro-hepatic ligament was composed of thin, delicate peritoneum, increasing in thickness and strength towards the right or pyloric end of the stomach. Retractors were introduced and the liver held aside by

placing a gauze sponge beneath a retractor. Three rows of interrupted silk sutures were then introduced so as to plicate and thus shorten the gastro-hepatic and gastro-phrenic ligaments in the following manner. The first row, beginning in the gastro-phrenic ligament, and extending across the gastro-hepatic ligament to almost opposite the pyloric orifice and hepatico-duodenal ligament, was introduced so as to form a plication in the centre of these ligaments, and included from above, downward or vertically, about 4 cm. of tissue (row No. 1). *They were practically* mattress sutures, including sufficient of the delicate tissue (1 cm.) to



FIG. 156. GASTROPEXY. Beyea's method.

insure against their tearing out. Five sutures, about one inch apart, were introduced from right to left and caught in hæmostatic forceps. The next row (row No. 2) of sutures was introduced in the same manner, but 2·5 cm. above and below the first two. Then a third row (row No. 3) was introduced just above the gastric vessels and a short distance below the diaphragm and liver. The suturing was strictly confined to the normal ligamentary supports, and the distance between the rows from left to right was increased with the length of the ligaments, being greater towards the right. The gauze sponges were then removed, and the first, the second, and finally the third row of sutures were secured, the stomach, particularly the pyloric end, being elevated to a little above the normal position.'

In the cases in which I have operated I have usually included in the final row of ligatures a portion of the stomach close to the lesser curvature.

Coffey's operation. This also, in my judgment, is a sound surgical procedure, which I have once adopted. Dr. Coffey writes (*Phil. Med. Journ.*, 1902, x. 506) :—

'The stomach is suspended in a hammock made of the great omentum. When the abdomen is opened the stomach is freed from adhesions and pushed gently upward into its normal position. A series of chromicized catgut sutures are then passed transversely across the abdomen, picking up on the one side the great omentum one inch below the stomach, and on the other the anterior abdominal wall. As to the technic, I think this can well be varied to suit the case in hand. If only the stomach is displaced and not much dilated, it will probably be sufficient to put one row of sutures across, about an inch below the attachment of the stomach. If the abdomen is much relaxed and the colon shows a decided tendency toward the prolapse in splanchnoptosis, it will be probably well to put two rows of sutures across, penetrating the entire thickness of the omentum just below its attachment to the colon. In this way such a broad line of adhesion will be constructed that it will practically be impossible for the organs to become prolapsed.

'In my first case I placed three interrupted chromicized catgut sutures, covering a space of about 2 inches, near the centre of that portion of the omentum attached to the dilated portion of the stomach. In my second case I used eight chromicized catgut sutures, covering a space a little more than 6 inches. In a case of a very much dilated stomach I would suggest extending the suture still further, taking in 8 or 10 inches across the omentum. The stitches have been passed about 2½ inches above the umbilicus and have been passed from a large longitudinal incision.'

Rovsing's operation. By this method the stomach is supported by three or four sutures passed horizontally through its outer coats. These stitches at each end are passed through the abdominal wall, where they are tied over a glass rod. The sutures are of silk and are allowed to remain four weeks, by which time the stomach is 'united solidly' to the anterior abdominal wall.

SECTION IV

OPERATIONS UPON THE STOMACH AND INTESTINES

PART II

OPERATIONS UPON THE INTESTINES

BY

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CHAPTER VI

GENERAL REMARKS ON THE TECHNIQUE OF OPERATIONS UPON THE INTESTINES

The continuous widening of the field of intestinal surgery that has taken place during the last twenty years has been accompanied by a steady tendency to simplification in the methods employed. Experience has shown the technical success of any particular procedure to depend primarily on the sufficiency of the suture employed, and the sufficiency of the latter to be in direct ratio to its simplicity. The first great advance from the through and through stitches employed by Astley Cooper was made in the introduction of the principle of plane apposition of peritoneal surfaces by Lembert, and the further adaptation of the same principle to the continuous stitch by Dupuytren ; thus the technique of the French School may be said to have dominated all subsequent developments.

Methods of suture. The chief requirements for a successful method of suture may be summed up under the following headings :—

1. Security.
2. Even coaptation of a sufficient peritoneal surface.
3. Adaptability to rapid insertion.
4. The avoidance of the production of obstruction in the lumen of the bowel by too free inversion of its wall.

The first question arising out of these requirements is the comparative advantage of a continuous or interrupted stitch. The advantages offered by the former method are so manifest that it has to-day been adopted by the great majority of surgeons. It is the more rapid, secures the more even coaptation of the surfaces, provides for reliable hæmostasis without necessity for the ligature of individual vessels, forms a circular line of support to the suture itself, should the bowel subsequently become distended (Jacobson), and allows of the use of as few knots as possible, thus eliminating the most dangerous element in a line of suture as far as infection by imbibition is concerned.

The alleged disadvantages may be briefly dealt with : the old established notion (founded on the behaviour of suppurating wounds of greater magnitude), that the giving of the suture at one point results in a loss of sufficiency of the whole line, has been definitely exploded by practical

experience; also the assertion that a continuous line injuriously affects the nutrition of the tissues included. The latter danger is readily avoided by not drawing the thread too tightly, while the same precaution suffices to ensure that the line of suture is not a source of greater narrowing at the point of union than is inseparable from the inclusion of the amount of bowel-wall necessary for purposes of coaptation.

Allowing these advantages of the continuous stitch, occasions arise on which an interrupted suture is advisable or even necessary, and its employment either in the simple or the mattress form is attended by excellent results. For general application, however, the following objections may be urged against the interrupted stitch. It takes more time to introduce, coaptation is not so exact, hæmostasis may not be ensured without the individual ligature of vessels, and, lastly, the number of knots necessary is an obvious disadvantage, since it has been definitely shown by Chlumsky that the direction of the flow in the thread by imbibition, and consequently the line of extension of infection, is towards the knot. The last objection may be eliminated by the use of one of the ingenious methods devised by Maunsell, Connell, Bishop, Wiggin, and others, in which the suture is so introduced that all the knots are tied within the lumen of the bowel; but none of these methods have up till now obtained any very general favour.

The general question of how great a thickness of the intestinal wall should be included in the suture may be said to be fairly definitely agreed upon. When two tiers of suture are employed the inner is very generally passed through the entire thickness of the intestinal wall, with a view to increase in the strength of union and the ensurance of reliable hæmostasis. It has, moreover, been shown by the successful employment of the methods of Connell and others that a single tier of stitches may be safely passed in this manner. When healthy intestine has to be dealt with, however, sufficient strength of union may be looked for from the outer tier of sutures, and, if the surgeon prefers, the inner tier may be made to include the mucous membrane only. The writer has for many years employed this method without cause to regret it, especially in lateral anastomoses. When combined with excision of superabundant mucous membrane, it has the advantage of producing less projection inwards of the line of union towards the lumen of the bowel than is the case when the whole thickness of the wall is included in the stitch.

The outer tier should dip deeply into the submucous layer, as so strongly enforced by Halstead and Gross.

Of the numerous methods of suture in use, the following may be mentioned as the most generally useful, and as comprising all that are necessary for successful intestinal union.

Lembert's suture. Originally devised as an interrupted stitch extending through the peritoneal coat only, this stitch has undergone various modifications, as in the substitution of continuous introduction, the inclusion of the muscular coat, and later, of the submucous coat also (see Fig. 157).



FIG. 157. INTERRUPTED LEMBERT'S SUTURE. Right hand, six Lembert's stitches, two tied. Left hand, four mattress stitches, one tied.



FIG. 158. CONTINUOUS LEMBERT'S SUTURE. Thread not drawn tight to show the course of the stitches and the folds raised by them.

As employed at the present day, the needle is introduced about a quarter of an inch from the margin of the wound to be closed, made to penetrate to the greater part of the depth of the submucous layer, and is then brought out about a tenth of an inch from the opening in the bowel and made to emerge on the free surface, having penetrated a similar depth and distance of the bowel-wall as on the first side; succeeding stitches are passed at intervals of three-sixteenths of an inch until the required length of suture has been attained.

When this suture is employed as a running stitch, it is a modification of Dupuytren's (see Fig. 158).

The method of introduction has been modified by Cushing by the passage of the needle parallel to the line of the wound instead of transversely to it.

In order to prevent a too great approximation of the two ends of the line of union, the blanket stitch or the tying of a knot in the line of suture at one or two places is sometimes employed, but neither of these methods is usually necessary.

Mattress suture. In this method (see Fig. 157) each suture encloses a small square of tissue. The most important result of its adoption and advocacy by Halstead has been a thorough appreciation of the advantage of penetrating to the submucous coat, but the method itself has the disadvantage of procuring a somewhat less even adaptation, since a series of short puckers is unavoidable. It is, moreover, an interrupted stitch. The advantage of the mattress suture is, however, sometimes great, as by its use a very firm hold is obtained, and this is especially the case when gut thickened by inflammatory infiltration has to be dealt with.

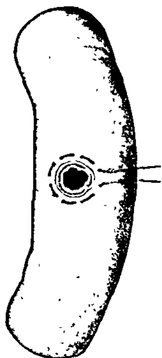


FIG. 159. PURSE-STRING SUTURE OF THE LEMBERT TYPE.

Purse-string suture. This method is of frequent utility in closing perforations of the intestinal wall, sinking the stump of the appendix, or closing the cut ends of the bowel when lateral union is made after an enterectomy. It can be applied with great rapidity, and is readily strengthened where necessary by the introduction of a more superficial line of Lembert's stitch. As in the case of Lembert's stitch, the needle and thread should be made to pass deeply into the submucous coat, or, under certain conditions, it may be passed through the whole thickness of the bowel.

A description of Connell's suture will be found on p. 436.

Sewing materials. For general employment no material is more useful and satisfactory than *silk*. Either Chinese or Japanese twist is usually chosen; the latter has the advantage of being the more tightly woven, hence it is finer and a given calibre possesses greater strength and less absorbent power than the corresponding size of Chinese twist. Equal tensile strength is possessed by Japanese twist two sizes smaller than that of Chinese twist.

Celluloid thread, in the form known as Pagenstecher's thread, is strong, smooth, and less absorbent than silk; its use is strongly recommended by Moynihan and others.

Catgut is also employed by some surgeons, especially for the inner lines of suture. It has the disadvantages of needing to be somewhat thicker than is necessary with silk or linen thread, its surface is less smooth, and it is more difficult to sterilize in emergencies. Its chief virtue, ready absorbability, can scarcely be said to be necessary, since the use of silk or linen thread seldom carries any troublesome complication with it from want of this property.

Needles for intestinal suture should be round bodied. The needle with a cutting edge not only makes a larger wound than is necessary, but also prepares the way for further cutting by the thread when the latter is tightened.

For the passage of Lembert's stitches a straight needle is the most convenient, as it most readily pierces the base of the small fold raised by the tightening of the last passed element of the stitch. When sutures need to be so introduced as to enter by the inner aspect of the bowel, or at a depth from the surface, a curved or semicircular needle is necessary.

Needles of the split-eyed variety are convenient; the only disadvantage is the occasional accident of slipping of the thread from a calyx eye when the tissue is hard or resistant, or when the double thread is considerably larger in calibre than the needle carrying it. In such circumstances an ordinary eye may be preferable, or the needle designed by Paterson may be used. The latter has the eye somewhat widened at the distal part, while the proximal end is so narrowed as to allow the thread to hitch firmly in this part. The hole made by the needle is slightly increased in size, but not more so than is necessary for the easy passage of the double thickness of thread at the needle's eye.

Clamps. For purposes of coprostasis some form of clamp is to be regarded as a necessity. A very slight degree of pressure suffices to entirely control the escape of fæcal contents from the bowel; hence the principle of elastic compression by the metal of the instrument itself embodied in the clamps of Doyen renders the use of any form of rubber sheathing unnecessary. The rubber sheathing increases the bulk of the blades, and interferes with the accuracy with which the necessary compression is applied.

No clamps are more generally useful than those introduced by Doyen. They possess the advantage of exerting an equable and sufficiently light elastic compression, while the length of the handle and blades serves the useful purpose when laid across the abdominal wound of retaining the

bowel readily in the required position, and preventing its retraction into the abdominal cavity. These clamps may be obtained of varying size and weight, and fulfil all ordinary requirements (see Fig. 160).

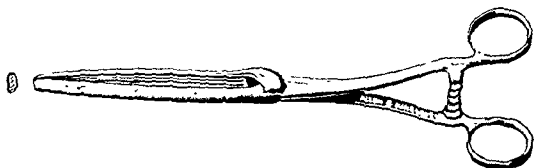


Fig. 160. DOYEN'S INTESTINAL CLAMP. Half-size.

FIG. 161. CARWARDINE'S INTESTINAL CLAMP. Half-size.

Various modifications have been introduced, such as the fenestration of the blades, to allow the introduction of sutures before the removal of the clamp, and, perhaps the most useful, that of Carwardine, which allows for the accurate fixation in proper relative position of the two portions of intestine to be united (see Fig. 161).

In Carwardine's clamp, by a simple arrangement, the handles are capable of fixation by a screw, so as to allow of exact parallelism of the pairs of blades; further, the blades themselves are light and elastic, and exert an equable compression on the whole width of the included gut.

The gastro-enterostomy clamp of Roosevelt is useful in lateral anastomoses, especially when the large intestine is included. The broad metal

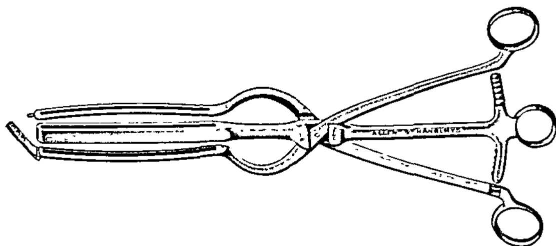


FIG. 162. ROOSEVELT'S CLAMP, AS MODIFIED BY MOYNIHAN. One-third size.



FIG. 163. LANE'S CLAMP. Two-thirds size.

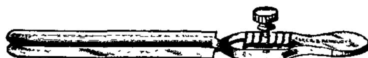


FIG. 164. MAKINS'S CLAMP. Two-thirds size.

central fixed blade serves the purpose of the gauze plug ordinarily placed on the deep aspect of the anastomosis before commencing the suture. This clamp may also be used for axial enterectomies, if the surgeon be content to leave the closure of the mesenteric gap to be the last step in the operation (see Fig. 162).

When smaller clamps are for any reason desirable, as when several pairs are necessary, Lane's clamp or the modified Dieffenbach's forceps devised by the writer may be employed. Either form has the advantage of occupying little space in the field of operation, or in the bag of the surgeon (see Figs. 163, 164).

GENERAL ANATOMICAL CONSIDERATIONS

The small intestine affords the most favourable conditions of the alimentary tract as far as the manipulations of the surgeon are concerned. Smooth and regular as to its serous surface, more or less cylindrical in outline, varying but slightly in calibre, and furnished with an abundant blood-supply, every essential for the successful union of wounds is presented.

Although for the most part clad with peritoneum so intimately connected as to allow the direction of the longitudinal muscle fibres to shine through the serous and tenuous subserous layer, yet at the attached margin where the true mesenteric layers allow the passage of the vessels and nerves to and from the structures of the bowel-wall a small interval exists, which in the early days of intestinal surgery proved the source of more disasters than any other single element in the field of operation. Again, in spite of the free blood-supply, the small intestine is singularly susceptible to gangrene if the mesenteric margin and arterial arcades be unduly interfered with.

The whole *length* of the tube is approximately 21 feet, but considerable variations occur (even 14 feet, Monks): such variations may be of moment when long portions of intestine need to be resected.

The small bowel occupies roughly the central parts of the abdominal and pelvic cavities, covered for the most part by the great omentum, and surrounded by the colon. Only two fixed and certainly determinable points exist: the junction of the duodenum and jejunum at the side of the second lumbar vertebra, and the termination of the ileum in the right iliac fossa. Between these points the bowel is attached by a mesentery of somewhat variable length, and the position of any one coil differs in individual subjects, and even in the same subject under varying conditions, such as posture, the degree of distension of successive parts of the bowel, or the presence of ascites or tumours encroaching on the peritoneal cavity. Some broad lines may, however, be laid down as to the location of the different parts in normal bellies, the position of the various coils being dependent, as has been shown by Mall, on the length and direction of the mesentery. Mall's (*Bull. Johns Hopkins Hospital*, 1898, vol. ix, p. 197) investigations suggest that in a considerable number of cases the coils are arranged in four successive groups from above downwards, and assume regular positions: (1) Coils passing to the left, occupying a space partly covered by the transverse colon, and reaching to the splenic flexure; (2) Coils passing to the right, crossing the umbilical region to the hepatic flexure; (3) Coils passing to the left loin and iliac region; (4) Dependent coils dipping into the pelvis.

These general indications are supported by the investigations of Monks, who divides the abdomen into three zones limited by oblique lines, the centre of which is determined by the two points of fixation of the mesentery (see Fig. 165).

Monks has further drawn attention to the fact that the upper end of any individual coil may be determined by drawing it out, passing the hand beneath the mesentery to the spine to ensure the absence of any twist, and then placing it transversely on the abdominal wall. With the gut so placed, the end to the patient's right will be the lower. Beyond these broad lines we can only trust for localization to such points as the comparative thickness, calibre, tint, the apparent direction of the mesenteric pull, and perhaps the arrangement of the blood-supply. With regard to the latter, Monks has pointed out that in the mesentery attaching the upper four feet of the small intestine, the vasa intestina tenuis form simple arcades, while the vasa recta are comparatively long (3 to 5 centimetres); in the middle portion of the gut the arcades may be two or even three deep, while in the lower third a more and more irregularly arranged network takes the place of the symmetrical arcades, and the vasa recta are short, not exceeding 1 centimetre. It must, however, be allowed that in the change from the thick, wide, red upper jejunum, with its frequently obviously distended lacteals, to the narrow, pale, thin lower part of the ileum, the alterations are so gradual that the formation of a certain opinion under the disadvantageous conditions often present from pathological causes is practically impossible.

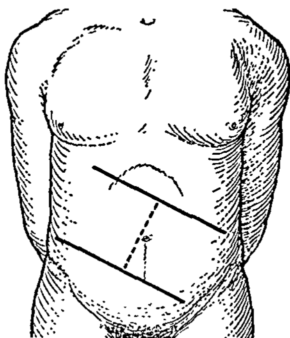


FIG. 165. ABDOMINAL ZONES. Three zones, containing in most instances the upper middle and lower thirds of the small intestine respectively. The dotted line indicates the root of the mesentery; the dark oblique lines cross the two extremities of this at right angles. (Monks, *Ann. of Surgery*, 1903, vol. xxxviii, p. 574.)

The large intestine in anatomical arrangement, structure, and function differs widely from the small, each anatomical segment possessing special characters of its own which influence surgical procedures to so great an extent that they are most conveniently considered together with the special operations which may require to be performed upon

them. Certain general characteristics only will therefore be mentioned here.

The average normal *length* in males has been computed at 4 feet 8 inches, in females at 4 feet 6 inches, with extremes of 6 feet 6 inches and 3 feet 3 inches (Treves). Pathologically, the length may be greatly increased when chronic distension has existed, such increase in length affecting particularly the more mobile portions, *e.g.* the transverse colon and the sigmoid flexure.

The general position of the large intestine in the abdominal cavity is marginal around the mass of the small intestine; this position, with the exception of the splenic flexure, facilitates access to the bowel, while taken together with the comparative fixity of the large intestine, it diminishes the danger of diffusion of infection from colic lesions to the general peritoneal cavity.

The different segments of the colon are fairly constant in position, the main element in their fixation being the peritoneal investment. As the most common arrangement, the ascending and descending colons are not only devoid of a mesentery, but the posterior surfaces have an area of some width in contact with the posterior abdominal wall, the extent of which varies with the amount of the distension of the bowel. The degree of fixation increases the difficulty of successfully uniting the bowel in enterectomy, or fixing it to the surface for the purpose of performing a colostomy, while the deficiency in the peritoneal investment affects the probability of effecting axial union safely, beyond affording the additional risk due to opening up the cellular tissue of the retroperitoneal space. Again, the uncovered area opens up the possibility of wound or rupture of the bowel without the confines of the peritoneal cavity. On the other hand, the mobile portions of the colon are exposed to dangers of their own; thus, kinking at the junction of the transverse colon with the hepatic or splenic flexures, or volvulus of the sigmoid.

The special arrangement of the muscular coat affects surgical measures. Thus, the tenia are useful in providing a firm grip for sutures, and the even surface afforded by them is that best fitted for approximation when a lateral anastomosis is made, while the inequalities dependent on the presence of the haustra are inconvenient in making lateral unions.

The vessels of the large intestine for the most part form but one simple arcade, except those for the flexures and the pelvic colon.

Common morbid conditions of the bowel. In connexion with these general anatomical points it must be borne in mind that, while in cases of injury or strictly local disease the surgeon may have comparatively normal tissues and anatomical arrangements to deal with, yet in disease these conditions may be enormously disturbed.

The position of mobile portions of the bowel may be altered either as the result of simple distension, the weight of a growth, habitual location in a false position, as in the sac of a hernia, or as a result of the pull of adhesions. On the other hand, the mobility of any portion may be decreased as a consequence of infiltration, either inflammatory or specific, of its mesenteric attachment (mesenteritis), by the spread of bowel growths to the surrounding parts, or by the presence of adhesions.

The condition of the bowel-wall itself may be such as to cause embarrassment. Simple distension may result in extreme tenuity and lowered vitality, increasing the difficulties of manipulation, and decreasing the chances of obtaining a successful union.

Compensatory hypertrophy in the presence of some source of obstruction may give rise to an opposite condition, the wall of the proximal portion of intestine being enormously thickened by tissue through which sutures readily cut, and of which the vitality is low; to which troubles incongruence in size of two segments to be joined may be added. Where a portion of intestine has been for a time unused the condition of atrophy and contraction may equally be a source of embarrassment, and the question of mere incongruence in size is here often much complicated by the presence of large masses of fat in the appendices epiploicæ and the mesentery, which commonly develop especially in connexion with portions of the large intestine which have been for any time cut off from performing their normal function.

In the neighbourhood of gangrenous gut a spreading cellulitis may extend over long lengths of the bowel, necessitating the removal of even some feet in order that a part capable of safe union may be obtained. Chronic œdema, or *stiffening from chronic inflammatory* infiltration, may give rise to much trouble in the closure of perforating ulcers, or in the performance of enterectomy in the neighbourhood of inflammatory tumours of the bowel; and, lastly, operations may have to be performed in the presence of specific disease, such as tubercle, widely disseminated in the peritoneum or bowel.

CHAPTER VII

THE REPAIR OF INJURIES, AND PERFORATIONS OF THE BOWEL

DEFECTS in the continuity of the wall of the intestine demanding surgical repair may be the result of either injury or disease. The multiplicity of causes which may lead to such defects necessitates numerous variations in detail, and even in general principles in their operative treatment.

Traumatic defects may be the result of wounds by sharp instruments accompanied by no serious destruction or loss of tissue, or by gunshot injury in which the same characters are more or less maintained; or they may be lacerations such as those produced by a fragment of a fractured rib or portion of the pelvis. Again, they may be inflicted by the surgeon in the process of separating adhesions, and then often, in bowel in conditions of varying degrees of inflammation.

Injuries differing little in general characters may result from the infliction of blunt force. Thus, the bowel may be perforated or divided by compression between a strictly localized force, such as that applied by the point of a horseshoe or carriage pole, and the bony wall of the abdominal or pelvic cavity; or it may give way more or less completely at the point of junction of a fixed and movable portion as the result of being stretched beyond its potential elasticity. These accidents form a very considerable proportion of those liable to occur in the abdomen. A consideration of 8,153 injuries of all classes admitted into St. Thomas's Hospital showed that 292, or 3 59 %, were located in the abdomen, and of the latter number 22, or 23 59 %, were injuries to the intestine.

Pathological perforations may result from such varying causes as chronic ulcer of the duodenum, peptic ulceration of the jejunum, typhoid or tuberculous ulceration of the lower ileum, cæcum, or colon, acute or chronic intestinal distension, acute septic infection and gangrene of the bowel, ulceration in diverticula, either congenital or acquired, or the extension or degeneration of malignant growths.

Although the immediate and ultimate result of accidents of either class are similar, yet two important distinctions must be drawn as affecting the treatment of the traumatic and pathological varieties. First, in

mechanical injuries the tissues bounding the defect in the intestinal wall are more or less normal in character, while in pathological perforations the bowel-wall is the seat of varying degrees of inflammatory change. Secondly, the escape of intestinal contents, either gaseous, fluid, or solid, is much more free and widely diffused in the pathological perforations. These points affect the site of the abdominal incision, the technicalities of suture, and the mode of dealing with the abdominal cavity. Hence each condition needs special consideration.

THE REPAIR OF INTESTINAL INJURIES

Indications for exploration. No individual symptom or even complex of symptoms can be regarded as certain evidence of a perforating injury to the intestine, but the following points may be set down as those to be specially considered in cases of suspected abdominal wounds or contusions.

1. *The process of exclusion of injury to other viscera.* Although a combination of injury to the intestine is obviously a possibility, yet this step is the most useful preliminary procedure in all cases of doubt.

2. *Consideration of the site of the injury, and of its nature.* In many instances the violence may have been exerted in an area where an injury of any other viscus than the intestine is unlikely, while ruptures of the intestine due to strictly localized force are in the great majority of instances to be found in the lower half of the abdominal cavity, where the possibility of crushing of the intestine between the applied force and the bony wall of the abdomen or pelvis is possible. A very large proportion of the localized ruptures are caused by such forms of violence as the kick of a horse or the impact of a carriage pole, while lacerations in which the bowel is torn apart in its continuity follow such accidents as the passage of a wheel over the abdomen or a crush between railway buffers.

3. *The amount of shock.* This point is only of importance when taken in connexion with other signs, since here, as in all serious abdominal injuries, the degree of shock is variable to a degree.

4. *A steadily rising pulse.* Although this sign in itself is really only one accompanying the development of infection, it is to be regarded as the most generally useful indication for exploration of the entire complex. The same remark in a lesser degree applies to a marked acceleration of the rate of respiration ; but this sign as a later one is far less useful.

5. *A rise in temperature.* In the earlier stages the temperature may be depressed by existing shock, but occasionally an early rise may be

of use. As a rule a serious rise of temperature only occurs when septic absorption has reached a degree calculated to render the chances of an exploration small; hence this sign is of little practical use.

6. A rupture is occasionally followed by *a sudden action of the bowels*, and, if the injury be in the lower segment of the canal, blood may be passed. These signs, though useful, if present, are so occasional as to rarely afford material aid.

7. *Extreme localized tenderness*, with corresponding rigidity and possibly immobility of the abdominal wall, are very important indications; in fact, no less so than the same signs in the presence of a pathological intestinal perforation.

8. In the early stages *fluid in the flanks* may indicate the presence of blood, but this is comparatively rare in the absence of injury to the mesentery or omentum, and its presence should excite suspicion of one or other of these injuries, or of damage to one of the solid viscera.

9. Injuries to the duodenum or colon may lead to the development of *cellular emphysema*, but usually only at a comparatively late date.

10. A wound of the bowel may occasionally be *obvious* on examination should an extensive opening exist in the abdominal wall; and, rarely, gas or fæces may escape from an opening of lesser size.

11. *Blood* is occasionally vomited.

12. Later indications, of less value as being merely signs of severe infection rendering any chances of successful treatment slight, are the symptoms and signs of progressing peritoneal infection.

Method of operation. *Site of incision.* In cases of wound of the intestine the site of the incision in the abdominal wall will generally be determined by the position of the original injury, except in wounds due to gunshots, when a consideration of the course of the entire track may be necessary.

In cases of subcutaneous rupture, external evidence of the point of impact of the occasioning violence may lead to the same course being taken; or in some rare instances, when the patient is seen early, extreme sharply localized tenderness may serve the same purpose as a bruise or graze in indicating the most suitable site for the exploratory incision. Usually, however, such evidence is not forthcoming at the date at which the operation has to be undertaken, and in the absence of any guiding signs a paramedian subumbilical incision is the most generally useful, bearing in mind the fact that such injuries are more commonly situated in the lower than the upper half of the abdomen.

The main exception to this rule is met with in lacerations of the jejunum at the duodeno-jejunal junction, but this injury rarely occurs

except where signs of injury to the upper abdomen, or a history of a fall on to the feet, exist.

During a period of eighteen years, 34 cases of rupture of the intestine were admitted into St. Thomas's Hospital; of these ruptures 26 were situated in the small intestine, 9 in the large; in one case both small and large intestine were implicated (duodenum and transverse colon). The injuries to the small intestine were distributed as follows: Duodenum, 5 (third part 4, first part 1); jejunum, 10; ileum, 8; small intestine, part not stated, 3. Of the injuries to the colon, we find cæcum, 1; ascending colon, 2; hepatic flexure, 2; transverse colon, 2; descending colon, 1; sigmoid flexure, 1.

The incision, wherever made, should be of sufficient length, or if made small at first for the purpose of preliminary exploration, should be lengthened if a wide area has to be overlooked, since the probabilities of diffusing infective matter are largely increased if the necessary manipulations for the search are made through a small opening.

When the abdomen has been opened, certain indications may at once give aid. Such are the escape of free gas, if the rupture be extensive; the presence of blood, or blood-clot; the local collection of fluid, due to reaction to infection by the peritoneum, and the development of plastic lymph; and lastly, the presence of intestinal contents. The amount of extravasation of intestinal contents is small, except in extensive lacerations; hence the detection of such matter usually at once leads to that of the opening by which it has escaped.

The search for the wounded spot will in the first instance be guided by any localizing evidence obtained from the history; failing this, or should the evidence prove elusive, the small intestine is best searched from below upwards, and the large from the cæcum downwards. When secondary reactionary peritoneal effusion has had time to take place, the fluid should be carefully mopped out as the search is proceeded with, since it is important not to effect its further diffusion during the considerable displacement of the bowels which may be necessary.

When the abdomen has been opened shortly after the infliction of an injury, the bowel in some cases of abdominal contusion may be in a state of spastic contraction in the area affected by the violence. This condition is not, however, of very great localizing importance, since in some individuals the intestine rapidly assumes this state when the abdomen has been opened and the bowel touched.

The local injury having been discovered, means should be taken, either by wrapping the affected coil in gauze and putting it into the hands of an assistant, or by the application of clamps, to prevent further extravasation of intestinal contents, and then the surrounding area

should be as thoroughly as possible cleansed by dry mopping. The latter effected, the injured coil should be well drawn forward, the general peritoneal cavity protected from further contamination by the introduction of gauze plugs, and the process of suture proceeded with. In dealing with punctured wounds the fact that the bowel lesions may be multiple must never be lost sight of.

An incised wound needs only the most simple treatment. A double line of suture should be introduced, the inner including the mucous membrane only, or, if preferred, the whole thickness of the bowel; the outer layer being a continuous Lembert's stitch, including the serous and muscular coats and dipping well into the submucosa.

Should the wound be of the nature of a puncture, it may be closed by a purse-string suture, to which a line of Lembert's stitch should be superadded, preferably introduced in a direction transverse to the long axis of the bowel.

If the lesions assume the character of lacerations the margins may be unfit for immediate approximation. This point must be carefully investigated, and if it is decided that tissue must be removed, the procedure will vary with the amount of destruction present. In some cases it will be necessary merely to freshen the margins to a requisite degree, and then to approximate them in a direction more or less corresponding to the transverse axis of the bowel, in order to avoid narrowing of the lumen as far as possible. In others, where the surrounding contusion is more extensive, a portion of the whole circumference must be removed, and a typical enterectomy performed. In regard to the latter procedure, it is as well to emphasize the fact that a circular enterectomy is not to be undertaken as a mere alternative. Experimental study, and experience of the results following the performance of enterectomy in cases of gangrenous herniæ, &c., appear to show that the proximal portion of the intestine for long distances remains afterwards in a thinned and more or less dilated condition. This matter will be more fully discussed later, but it suffices here to lay weight on the fact that avoidance of a complete solution of continuity of the nervous plexuses is always to be aimed at, even if the more perfect cosmetic result is not obtained.

Repair of ruptures of the small intestine. The damaged portion of the bowel having been localized, three main types of injury may require to be dealt with.

1. *The laceration may not have extended to the lumen of the intestine.* Such injuries are usually the result of combined pressure and tearing. An illustration of them is given in Fig. 166. Here the serous and muscular coats have been ruptured and widely separated from the mucosa

and submucosa, the lesion being accompanied by a tear in the mesentery which led to the death of the patient from internal hæmorrhage. It is well to bear in mind that the latter combination is not infrequent, since injuries of this type usually *result from the application of diffused* violence such as the passage of a cart-wheel over the abdomen. In dealing with extensive incomplete ruptures, special care must be devoted to the examination of the state of the mesentery, since, putting aside the danger of further hæmorrhage from the wound, the vitality of the portion of intestine involved may be hopelessly compromised by interference with its blood-supply.

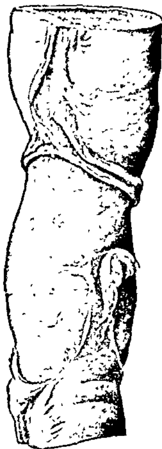


FIG. 166. NON-PERFORATING INJURY TO THE SMALL INTESTINE. The peritoneal and muscular coats are separated from the mucosa, in which no solution of continuity has occurred. (*St. Thomas's Hospital Museum*, No. 1001.)

Small serous or sero-muscular rents are treated by a single series of deep Lembert's stitches. Even when very small, if ununited, they afford the probability of the future development of undesirable adhesions. Extensive lesions demand the excision of the implicated length of bowel. The enterectomy, in the case of the small intestine, will be of the axial type. If the mesentery be not seriously damaged, it may be separated from the bowel and plicated, care being taken to so suture the freed margin as to close any opening likely to serve as a possible gap through which the intestine might travel later and become strangulated. The projecting fold should be sutured to the surface of the mesentery (see Fig. 167).

2. *The lesion may consist of a limited perforation* more or less closed by eversion of the mucous membrane; a large example of this is illustrated in Fig. 168. In ruptures caused by strictly localized violence, as applied by the point of the shoe of a horse, the opening may be very small. This is the most satisfactory for the work of the surgeon; the local damage is limited, the lesions are usually single, and a simple suture meets every requirement. The margins seldom need any refreshment, and the openings may be closed by an inner layer of through and through sutures, either passed as a purse-string, in the case of small wounds, or as a continuous line, this layer being buried by a second line of deep Lembert's stitches. If the opening is of material size, whether

transverse or longitudinal in direction, it should be sutured in the transverse axis of the bowel.

3. *The lesion may implicate the whole circumference of the bowel.* In Fig. 169 an instance is illustrated in which three-quarters of the circumference was torn. In such injuries an axial enterectomy and reunion is indicated.

The cleansing of the peritoneal cavity is completed after the suture of the wound or rupture. The exposed coil may be washed with saline solution, and the immediate neighbourhood wiped with a moist sponge, care being taken to remove any blood-clot which may have escaped the preliminary sponging in the surrounding area.

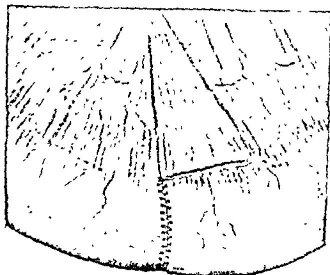


FIG. 167. PLICATED MESENTERY. Edge not sewn, and flap of mesentery loose.

The wound in the abdominal wall is then closed by suture in layers. The provision of drainage is to be avoided if possible, and is unlikely to be necessary in cases dealt with during the first twenty-four hours after the occurrence of the accident. If severe inflammation be met with, drainage must be provided for by the insertion of a tube and one or more gauze plugs, and the external wound should be left sufficiently open to give a free vent.

Repair of wounds or ruptures of the large intestine. Small wounds of the large bowel on the peritoneal aspect possess some special characteristics due to the small disposition of the more solid fæcal contents to escape. In many cases of small wounds this tendency is so marked that the amount of escape gives rise to little more than a mere local infection, which may be followed by the formation of protecting adhesions and the development of an abscess.

In this segment of the intestine another condition, shared by the second and third portions of the duodenum, has to be considered. In either situation a portion of bowel unprovided with a serous covering may be implicated. Some of the more important consequences of this circumstance should be mentioned. Thus, the great advantage of the rapidly agglutinating serous surface is lost, the wounds are often in very inaccessible situations, the openings are comparatively fixed and less

liable to be closed by intestinal contraction, while, lastly, intestinal contents are extravasated into and infect loose cellular tissue far less easily cleansed than the smooth even surface offered by the peritoneum.

Extra-peritoneal wounds and ruptures then demand special treatment. Theoretically, suture of the wound is the proper course to follow; practically, it can rarely be effectively performed. In the first place, diagnosis is often made proportionately late, when serious infection of the



FIG. 168. RUPTURE OF THE SMALL *INTESTINE, INVOLVING* NEARLY HALF THE CIRCUMFERENCE OF THE BOWEL. Marked eversion of the mucous membrane. (*St. Thomas's Hospital Museum,* No. *1006.*)

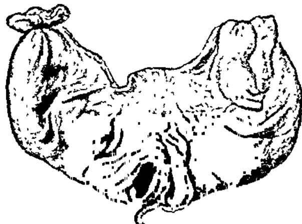


FIG. 169. A RUPTURE INVOLVING THREE-*FOURTHS OF THE CIRCUMFERENCE OF THE* INTESTINE. Moderate eversion of the mucous membrane. Inflammatory lymph on the neighbouring surface. (*St. Thomas's Hospital Museum,* No. *1007.*)

tissue has already developed; secondly, the results of direct suture have been far from satisfactory. Two alternatives exist: (1) The enlargement of the wound and its practical conversion into a temporary artificial anus, the bowel being brought to the surface and either sutured there or fixed by the insertion of a Paul's tube, efficient drainage of the surrounding wound being established; (2) The fæces may be temporarily diverted by the establishment of an artificial anus in a convenient proximal portion of the bowel, and the wound itself be drained.

Prognosis and results. The prognosis in cases of rupture of the intestine should not necessarily be bad when the lesions are

unaccompanied by coexistent injury to other parts. The indifferent results obtained up to the present time are in great measure attributable to difficulties in diagnosis, from the fact that the initial symptoms are often quite incommensurate with the gravity of the lesion, and in consequence many operations are undertaken at a time too remote from the reception of the injury to afford reasonable chances of successful treatment. To ensure a reasonable chance, the operation must be performed during the first twenty-four hours.

Of 34 cases treated by operation in St. Thomas's Hospital, 9 recovered, (mortality 73·5 %), the first successful instance being the classical case of Croft. 24 of the cases implicated the small intestine; of these 5 recovered (mortality 79 %); and 10 implicated the large intestine; of these 4 recovered (mortality 60 %). Of the last 22 cases occurring between 1893 and 1907, 8 recovered (mortality 63·6 %).

Berry and Guiseppi (*Proc. Roy. Soc. of Med.*, 1908, vol. ii, p. 1, Surg. Sect.) have analysed the results obtained in ten London hospitals during the last fifteen years, and find the mortality to have amounted to 87·2 %.

So little weight can be placed on the results obtainable by collation of successful published cases that none are included.

Speaking generally, it is clear that wounds or ruptures of the small intestine, however caused, are more formidable injuries than those affecting the large bowel; but some exceptions must be made to this statement. Thus, certain segments of the large bowel, as the transverse colon and the sigmoid flexure, share with the small intestine the disadvantage of occupying an area in which intestinal movement is free and the conditions for the rapid spread of infection are favourable. Again, extra-peritoneal ruptures of the colon or duodenum lead to the occurrence of infection of the retroperitoneal tissue, a situation in which infection can be less successfully dealt with at the time of operation, and in which it is difficult to arrest the process by incision and evacuation.

OPERATIONS FOR GUNSHOT INJURIES TO THE INTESTINE

Although in their results these accidents differ little, if at all, from the corresponding injuries of civil practice, yet, both in regard to difficulty of diagnosis and to the question of treatment, they present features of their own which render a special consideration of them convenient.

Indications. The indications already set forth on p. 373 relating to the injuries of civil practice are of the same import in dealing with gunshot wounds, but certain special points need elaboration.

(i) *With regard to the site of the injury.* The military surgeon may be in the same position as the civil practitioner when no aperture of

exit is present, but in a large proportion of cases a completed track through the body exists, and the advantage of the information as to the part of the abdominal cavity traversed may be considerable. Certain tracks have been observed to be especially unfavourable; thus wounds passing from flank to flank, the track of which crosses fixed portions of the colon and complicated coils of the small intestine. These wounds are particularly dangerous when situated between the eighth rib in the mid-axillary line and the crest of the ilium. Above this level, the liver or liver and stomach are often alone implicated, while wounds crossing the false pelvis have been observed to traverse the area occupied by the intestine without inflicting injury somewhat frequently. Antero-posterior tracks directly crossing the area occupied by the small intestine are especially dangerous; in such the bowel rarely escapes injury.

Wounds passing obliquely from the front of the abdomen to the loin, although dangerous to the colon, often miss the small intestine, and vertical tracks, either descending from the thorax and terminating high in the anterior abdominal wall, or ascending from the pelvis and opening in the subumbilical area, are comparatively favourable to the escape of the intestine.

(ii) *Nature of the violence.* Injuries caused by portions of large projectiles, as shells, do not differ from serious lacerated wounds in civil practice. In the case of bullet wounds the size of the projectile and the velocity it may possess at the time of impact with the body are of considerable importance. Bullets of the larger sporting variety of the Martini-Henry class (calibre 0·45 inch) may be regarded as never likely to enter or traverse the abdominal cavity without occasioning serious injury, and wounds of any part of the intestine caused by them can never be expected to heal spontaneously. The same remark applies in lesser degree to bullets of smaller calibre which have 'set up' before or after impact with the body. Thus, a large irregular wound, or the fact that the bullet has pierced or comminuted bone prior to traversing the area occupied by the intestine, may be an important element in deciding on an exploration. High velocity at the time of impact, in my experience, is on the whole a favourable moment as far as abdominal injuries are concerned, provided that the soft parts only are struck. Bullets travelling with a low velocity are more liable to be retained; they may possibly turn over during their course across the abdomen, and the displacement of the bowel due to laterally distributed force is less likely to occur. Gas or fæces may occasionally be noticed to escape from the wound in gunshot injuries.

In speaking of the special indications for exploration in cases of

gunshot wounds of the abdomen, certain *sources of fallacy* to which these injuries are liable must be mentioned. First of all, the intestine may actually escape in spite of the fact that the apertures of entry and exit indicate a track in the course of which injury to the bowel might be deemed inevitable. Many factors may contribute to this result. The apertures of entry and exit by no means always accurately indicate the actual course of the track. Thus, Cheatle has shown experimentally that the level of a certain portion of the skin may vary immensely in different attitudes of the body; thus, a point in the mid-axillary line may ascend not less than 5 inches when the arm is raised above the head. Lesser degrees of displaceability were noted in other parts of the body, as over the iliac crests and groins in varying relative positions of the trunk and lower extremities. Further, as Cheatle illustrates by reference to the surgical use of the Trendelenburg position, the portion of the bowel occupying any given area within the abdomen may be widely altered by changes in the position of the trunk. Again, the skin at the aperture of entry, and, to a lesser degree, at the aperture of exit, may be displaced by the bullet itself, when the latter strikes tangentially (G. L. Cheatle, *Journ. Roy. Army Med. Corps*, 1906, vol. vii, No. 1, p. 31).

The bullet in its course, although striking the intestine, may only cause contusion or a non-perforating abrasion. This form of escape is furthered by the general tendency of the travelling bullet to effect lateral displacement of the structures of the body without serious destruction of tissue, so well illustrated by the perforation of the peripheral nerves. A general consensus of opinion favours the assumption that when the bowel contains little beyond gas, it is more likely to escape perforating injury.

The injury or escape of any portion of the bowel is definitely influenced by the degree of mobility of the portion of intestine concerned. Thus, injuries crossing the fixed portion of the colon are usually perforating, and the same may be assumed for the more fixed segments of the small bowel, such as the duodenum and the upper end of the jejunum and lower end of the ileum respectively. The location of a wound in a fixed or mobile portion of the intestine is also of the first importance with regard to rapidity of spread and extent of the resulting infection.

Lastly, many surgeons are of opinion that perforations, when small, may be closed temporarily by the eversion of the mucous membrane, become rapidly sealed by lymph, and heal spontaneously. The writer has little belief in this assumption as far as the small intestine is concerned.

Mention should be made of the fact that the small intestine may be ruptured by a blow from a spent bullet, or at any rate a bullet which

does not penetrate either the skin or the abdominal cavity. Watson Cheyne recorded such an instance during the South African War, in which the small intestine was found ruptured in two places (*Brit. Med. Journ.*, 1900, vol. i, p. 395).

The above particulars appeal alike to the civil or military surgeon, but the military surgeon in the field must take other factors into consideration; thus, the time at his disposal, the presence or absence of efficient assistance, and the circumstances under which the exploration may have to be carried out, which latter may themselves afford dangers scarcely less formidable than those dependent on the original injury. Hence, an expectant attitude may often be properly assumed in circumstances under which, in civil practice, it is an obvious duty to explore the abdomen. Thus, when the fixed portions of the colon have been exposed to injury, the experience of the not infrequent localization of the infected area and the later formation of a circumscribed abscess may well justify primary non-interference, where in civil practice prompt intervention would be demanded.

In referring to temporizing measures in cases of colic wounds, exception should be made of all injuries in which the wound lies in a track traversing the pleura; in such the risk of pleural infection is so great, and the result so uniformly serious, that all should be submitted to prompt treatment.

Operation. When exploration is decided upon, the course taken by the bullet, as indicated by the position of the apertures of entry and of exit, usually determines the site of incision, due regard being paid to the sources of fallacy already alluded to.

On opening the abdomen, some indications peculiar to bullet wounds may aid in the detection of the part of the intestine injured. Thus, the coils bounding the track of the bullet may be ecchymosed, and the amount of hæmorrhage, if small in amount, may also lie in the course of the track. In other cases the place of the ecchymoses may be taken by non-perforating abrasions. Certain difficulties are also to be borne in mind. Thus, the portion of intestine struck and perforated may have widely changed its position, either as a result of active retraction, or the return of the particular coil to the locality proper to the particular position of the body in which the examination is made. Thus, a wound of entrance just external to the left posterior spine, and of exit 1½ inches within the left anterior superior iliac spine, suggested the probability of a wound of the sigmoid flexure. The sigmoid was found to be ecchymosed and adherent to the opening corresponding to the aperture of exit, but no perforating lesion was discovered. Further exploration revealed three openings in a length of 2½ inches of the jejunum, the coil having retracted

upwards to a level some inches higher in the abdomen than was indicated by the course of the track. The presence of three openings illustrates the fact that wounds from bullets may be caused by the cutting away of a portion of the bowel-wall by a passing bullet; while in every case the natural tendency of these lesions to be multiple must be given due weight, and a more extensive search made than is necessary in ruptures of the bowel.

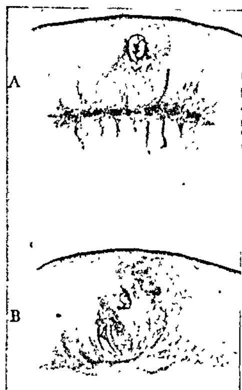


FIG. 170. GUNSHOT INJURY TO THE SMALL INTESTINE BY 0·276 INCH MAUSER BULLET. A, Aperture of entry, circular, mucous membrane everted; B, Aperture of exit, slit-like, mucous membrane everted; note the abundant ecchymosis around. (*St. Thomas's Hospital Museum*, Nos. 1008 A and B.)

The intestinal wound itself may vary in character. If the portion of the bowel has been struck at right angles, a small circular hole, through which the mucous membrane protrudes like a granulation, may be seen at the point of entry, while the aperture of exit will probably assume a more slit-like character with protruding mucous membrane surrounded by a considerable area of ecchymosis (see Fig. 170, B). If the bowel has been struck tangentially, a wide gaping slit of varying length with protruding mucous membrane will be found.

The closure of a simple perforation caused by a bullet of small calibre, such as is seen in Fig. 170, is a matter of extreme simplicity. The margins of the wound may be regarded as of normal tissue, since the amount destroyed by the contusion is minimal in extent, and the procedure differs in no particular from that already given for incised wounds (p. 376).

Certain features peculiar to gunshot injuries may, however, affect the nature of the measures necessary. Thus, the fact that the blood-supply of the bowel-wall may be interfered with by coexistent wound of the mesentery may render a typical axial enterectomy a preferable procedure to adopt, even when the intestinal perforation itself is small, especially in the case of a wound of the small gut.

Gunshot wounds of the large intestine, seen only at a period when localization of the infection has resulted in the formation of a circumscribed intraperitoneal abscess, should be treated by simple incision of the

abscess, and no attempt should be made to suture the bowel. Such cavities, when freely drained, usually heal by granulation without further trouble. Extra-peritoneal injuries should also be treated by free exposure of the retroperitoneal space. In such cases, however, the infection has usually spread widely, and is difficult to deal with; hence they do badly.

Prognosis. As already remarked, the certain diagnosis of perforating lesions of the intestine is often difficult or impossible. For this reason the small number of cases which came under my own observation in the South African War were divided into two classes: those in which the injury was proved, and those in which a wound in the intestine was possibly present. Of fifteen cases divided in this way, we find five certain perforations of the small intestine, all of whom died, and ten wounds in the area occupied by the small intestine, all of whom recovered. In the large intestine there were four cases of possible perforation, all of whom recovered, while of eight certain cases four, or 50 %, recovered (Makins, *Surgical Experiences in S. Africa*, p. 447).

In Surgeon-General Stevenson's Report (*Surg. Cases noted in the S. African War*, 1899-1902, pp. 80, 86), it is stated that of 35 cases in which the small intestine alone was wounded, 13, or 37·1 %, recovered, independently of the performance of any operation. Of 40 cases of injury to the large intestine, 27, or 67·5 %, recovered.

In gunshot injuries of the intestine, as in other parts, the calibre of the bullet inflicting the wound is of first importance, and it may be laid down as a general proposition that the smaller the bullet, the greater the chance of successful treatment by operation, and the ease with which it may be carried out.

THE REPAIR OF INJURIES TO THE MESENTERY

Wounds of the mesentery are usually limited in extent, and comparatively easy of treatment. Ruptures, on the other hand, are not rarely very extensive. Ruptures or lacerations are caused by injuries affecting the middle and upper parts of the abdomen; very often the patient has been run over. The mesentery is then crushed against the prominence of the spine, or the mesentery is torn, as a result of dragging from the violent displacement of the intestines. The cardinal indication for operation in these injuries is internal hæmorrhage.

Operation. A paramedian incision, the centre of which lies well above the umbilicus, is most convenient, and when the rupture is an extensive one the wound will probably need considerable enlargement. The bleeding vessels must be secured by forceps and tied, and the rent

in the mesentery itself closed by suture. The method of closing the rent in the mesentery after enterectomy advocated by Moynihan, *i.e.* of approximating the edges by tying vessels on the opposite sides of the rent with the same ligature, is particularly appropriate here, since it is of the utmost importance that the stitches should not perforate uninjured vessels and still further prejudice the vitality of the bowel. In estimating the seriousness of any given vascular injury, it is obvious that the obliteration of even several of the trunk vasa intestina tenuis is of less importance than a comparatively limited injury completely severing the continuity of the vascular anastomotic arcades.

If the rent be extensive very free displacement of the bowel is necessary to thoroughly expose the field of operation, hence the abdominal wound must be large, and a considerable degree of evisceration may be unavoidable. Precautions must therefore be taken to protect the exposed bowel with warm towels. Suture is the proper method in either small or very large rents. When the rent is of moderate degree, but of such a nature as to entirely cut off some three or more inches of bowel from its direct blood-supply, it is safer to resect the affected portion of bowel as well as close the defect in the mesentery.

In connexion with this subject it may be pointed out that the prevailing belief as to the danger to the vitality of the bowel in mesenteric injuries is probably somewhat exaggerated. Evidence certainly exists to show that very extensive injuries may be recovered from. Thus the writer has seen a case in which, as the result of the handle of a wheelbarrow being driven against the abdomen by a passing motor-car, almost the whole length of the base of the mesentery was torn across. The rent was repaired by A. Y. Pringle and the patient made a good recovery, some three months later being well, except for occasional attacks of diarrhœa. Mayo Robson has recorded a case of successful ligature of the superior mesenteric vein (*Brit. Med. Journ.*, 1897, vol. ii, p. 77). Again, the observation of Haberer (*Brit. Med. Journ.*, 1906, vol. i, p. 882) that the obliteration of the inferior mesenteric vein by thrombosis in the neck of a duodeno-jejunal hernia had not caused gangrene, bears upon this point.

Wounds or laceration of the great omentum are sutured in a similar manner. When the rent in the omentum is transverse in direction, it is advisable to remove the distal portion and suture the margins of the gap. In wounds of either mesentery or omentum, the importance of not leaving a hole through which intestine can pass and become strangulated is obvious, and in cases of injury to the omentum care should be taken to avoid leaving raw stumps liable to form adventitious adhesions with their attendant dangers.

OPERATIONS FOR PATHOLOGICAL PERFORATION OF THE INTESTINE

Perforations of this character may occur in patients with long-standing symptoms of the disease which gives rise to them, or their advent may be sudden, forming, to the patient at least, the first indication of anything seriously amiss.

Whatever the cause of the perforation, the subsequent course of events is usually towards a fatal issue in the absence of operative treatment, except in the comparatively uncommon cases in which the process of perforation is subacute and the diffusion of infection is limited by protecting adhesions developing around the opening.

The site of the incision, made for the purpose of dealing with pathological perforations, is often determined by the conclusion arrived at as to the primary nature of the disease, and on opening the abdomen immediate confirmatory or other evidence may be furnished as to the nature and locality of the lesion. Free gas may at once be liberated from the peritoneal cavity, pointing to the probability of the existence of a perforated viscus, or the characters of the fluid effusion found may afford useful aid. Thus, if gruel-like fluid, odourless and accompanied by the free deposition of lymph, be disclosed, we suspect the stomach; if the matter be deeply bile-stained, the duodenum or upper jejunum; if stinking, the vermiform appendix or a portion of the lower bowel; or if sanguineous, malignant disease.

PERFORATIONS OF THE DUODENUM

Perforations of the duodenum may supervene on ulceration of an acute or chronic character, but the great majority are of the latter variety, although the ulcer may have been latent as far as symptoms are concerned. The disease is far more common in men than in women, some 70% of recorded cases occurring in the male sex. It is also more frequent in middle life or later, although cases have been met with in patients as young as ten years, and in one recorded case in an infant of ten weeks (Cecil E. Finney, *Proc. Roy. Soc. of Med.*, 1908, vol. ii, Sec. for study of Dis. in Child., p. 67).

Indications. Actual perforation is indicated by a sudden attack of severe pain, usually in the upper abdomen, accompanied by acute local tenderness above and to the right of the umbilicus; the patient may vomit, occasionally the vomit contains blood. The right rectus muscle becomes rigid, and the general respiratory movements decreased,

sometimes markedly restricted in the upper segments of the abdomen. The liver dullness may become rapidly obliterated.

With time the area of physical signs widens, although it remains for long limited to the right half of the abdomen. Dullness in the right loin may develop, while extension of the area of pain and tenderness in the direction of the right iliac fossa has given rise, in a large number of instances, to confusion with a perforation of the appendix. In fifty-one cases of operation collected by Moynihan, a primary incision, intended to deal with the appendix, was made in no less than nineteen instances.

The occurrence of perforation is attended by signs of collapse, followed by a great increase in the pulse rate and elevation of the temperature; if the condition be not promptly attended to, signs of general peritoneal infection rapidly develop.

Operation. The operation is best commenced with the patient in the supine position. An incision is made over the right rectus muscle 1 inch to the right of the median line. The sheath is incised, and the anterior connexions having been carefully separated from its deep aspect, the muscle itself is displaced to the right. The freeing of the intersections is accompanied by some hæmorrhage from small vessels which needs to be controlled, or it may otherwise continue during the further part of the operation. The length of the incision should not be less than 5 inches, since not only has the perforation to be dealt with, but also a considerable area of the abdominal cavity to be cleansed.

The posterior layer of the sheath of the rectus is divided, and the peritoneum opened. The escape of gas and a variable amount of fluid often follow this step; the latter must be at once mopped up.

It is convenient for the further stages of the operation, either now to raise the shoulders of the patient by elevation of the upper half of the table, or to distend an air-cushion, previously arranged in a collapsed condition beneath the lower ribs. This procedure facilitates the retention of the lower abdominal contents, enlarges the field of exposure, and allows the duodenum to be more readily brought up to the surface.

The search for the perforation is now proceeded with; in early cases, when no previous peritoneal changes have occurred, this is usually readily found; if any difficulty arises, it is best met by tracing the duodenum from the pylorus downwards. When old peritoneal changes have occurred, or when operation has been deferred beyond twenty-four hours, adhesions may render the search much more difficult. The same method of exposure is, however, to be adopted; thus the liver is drawn upwards, the transverse colon downwards, and the stomach to the left.

The perforation is most commonly on the anterior aspect within

3 inches of the pylorus, the most manageable portion of the gut. Of thirty-two cases subjected to operation at St. Thomas's Hospital, the opening was found in the first part in twenty-eight, in the second part in three, and at the junction of the first and second parts in one. Of 131 cases collected by Collin, 119 perforations were in the first part, eight in the second part, and four in the third part.

The opening is commonly a small punched-out orifice with thin margins, forming the centre of an indurated area corresponding with the ulcer within the bowel. From it, gas and bile-stained contents escape freely on manipulation. In rare instances the opening may be large, and the escape of duodenal contents has then been abundant. It must also be borne in mind that occasionally more than one perforation is present. The perforation having been located, the further escape of contents is controlled by pressure with a plug, the immediately surrounding area is rapidly cleansed, and the surrounding viscera protected by the introduction of strips of gauze.

It is rare that excision of the ulcer should be taken into consideration, since experience has shown it to be unnecessary, and the removal of tissue necessitates eventual narrowing of the lumen, but, if thought advisable, the margins of the perforation may be refreshed. Usually the opening is closed by inversion, which may be effected by one of two methods. If the opening be small and the surrounding infiltration of the bowel-wall moderate in degree, an ordinary purse-string suture will suffice; if the bowel-wall be stiff and too brittle to give secure hold to the purse-string stitch, a single mattress suture, passed in a direction transverse to the long axis of the gut, gives a safer hold and inverts the perforation effectually. The closed opening is then further sunk by the introduction of a second line of continuous Lembert's sutures, also passed in a direction transverse to the long axis of the bowel. Should doubt still exist as to the efficiency of the closure, this is a position where the application of an omental graft is easy and open to no serious objection.

The opening closed, attention is turned to the permanent cleansing of the peritoneal cavity. When effusion has been moderate in amount, and is limited to the right half of the abdomen, the whole procedure may be effected from the existing wound, and, bearing in mind the common course taken by these effusions, especial care is extended to the hepato-renal pouch, the two margins of the ascending colon, the right loin, and to make sure that the sac of the lesser omentum is free. When the effusion has extended into the pelvis, or to the general peritoneal cavity, a second paramedian subumbilical incision, with displacement of the rectus muscle outwards, is needed to allow of these parts being reached.

The process of cleansing should be carried out by the careful intro-

:tion of long, soft, dry, sterile gauze plugs; the only part in which shing can come into consideration is the area immediately surrounding perforation itself, elsewhere it is unnecessary and harmful.

When the general state of the patient is such as to warrant the in-ased expenditure of time involved, and the local condition of the area peritoneum in the immediate vicinity of the perforation is not such as render the risk of diffusing infection too great, recent experience is ongly in favour of the immediate establishment of a gastro-enterostomy. is step is calculated to give relief to the sutured spot, and also to favour ultimate cicatrization of ulceration present.

Lastly, the question of drainage has to be decided upon. In this ation it must be borne in mind that the duodenal contents may be rile, or, at any rate, not highly septic, and if effusion has been only al and existent for less than twenty-four hours, no drainage is necessary. en when the effusion is abundant, it is in the main a fluid the result of itoneal reaction, and in favourable cases all drainage may be dispensed h. The insertion of a pelvic drain is, however, very generally recom-nded, to be retained for the first twenty-four to thirty-six hours.

Local drainage is to be avoided, if possible, as unfavourable to the best ances for the intestinal suture, and is to be employed only in the presence bad local conditions.

The abdominal wound is closed by suture of the posterior layer of the tus sheath together with the peritoneum, replacement of the rectus iscle, suture of the anterior layer of the sheath, and, lastly, suture of skin. If forceps have been left on the small vessels of the subcutaneous er of fat, the latter may be approximated by using the same ligature obliterate the opposite ends.

Operations for subacute perforations, and perforations of the posterior ll of the duodenum. When the process of perforation has been gradual d an abscess localized by firm adhesions has formed, primary interference th the opening into the gut is dangerous and not permissible. When lesion is situated in a peritoneal clad portion of the bowel, the abscess ll occupy some part of the area which accommodates the effusion in ute perforation; thus it may point below the costal margin, near umbilicus, in the right iliac region, or it may even descend into the lvis.

Should it be desired to expose the posterior non-peritoneal clad aspect the duodenum in cases of injury or perforation, this portion of the wel may be approached from the right loin, by an incision similar to at employed for exposure of the kidney, the lower pole of which latter gan forms a rallying point for the localization of the duodenum.

Such an incision is superior to that devised by Braune, since it affords

more space for manipulation and allows the peritoneum to be more readily displaced. The method of mobilization of Kocher shows that the duodenum and pancreas are readily lifted for purposes of exploration. In this operation the position of the right colic artery and the relation of the vessels and ducts to the duodenum and head of the pancreas need to be borne in mind.

Prognosis and results. The results of these operations have undergone a steady improvement corresponding with the comparatively greater frequency with which they are performed. Experience has definitely shown that nothing short of an effectual closure of the perforation is of avail, since all recorded cases in which simple drainage has been resorted to have terminated fatally.

In a collation of fifty-one cases by Moynihan, published in 1901 (*Lancet*, vol. ii, p. 1685), seven recoveries only occurred, a death-rate of 86·27%. In a collation of 155 cases by Mayo Robson, published in 1906 (*Brit. Med. Journ.*, vol. i, p. 248), fifty-two recoveries are recorded, the mortality being reduced to 66%.

During the years 1890–1907 inclusive, twenty-three operations for perforated duodenal ulcer were performed at St. Thomas's Hospital, with eight recoveries, a result corresponding to Mayo Robson's table (65·2%). In five of the earlier operations the perforation was not closed, and if these cases be subtracted we have eighteen sutured perforations with eight recoveries, a reduction of the mortality to 55·5%.

The interval between the occurrence of perforation and the operation for its closure is of the same importance as in the case of gastric perforations. Weir, in commenting upon twenty-five operations, states that in thirteen in which an interval exceeding thirty hours elapsed before operation, all died; while of twelve in which the operation was undertaken after less than thirty hours, four died, a mortality of 33·3%. The same point is illustrated in Mayo Robson's collation. Thus, in sixty-one cases in which the operation was undertaken before twenty-four hours, the mortality was 37·7%, while in sixty-three in which more than twenty-four hours had elapsed, the mortality reached 82·5%.

Death most frequently results from peritoneal infection, and this has often commenced prior to the operation. Other causes of death are lung complications, which will no doubt be rarer with the general adoption of the 'almost sitting' position after operation; the presence of a co-existent second perforation of the duodenum itself, or of the stomach; local abscesses, or abscesses in the subdiaphragmatic or perisplenic area.

PERFORATION IN ENTERIC FEVER

This accident accounts for a very large proportion of the mortality from enteric fever. In a series of 2,533 cases of enteric fever collated by Hector Mackenzie from the reports from four London General Hospitals (St. Bartholomew's, St. Thomas's, Middlesex, and Charing Cross), 346, or 13·4%, died. Perforation had occurred in no less than 117 of the fatal cases; thus, in a proportion of nearly one to three (*Lancet*, 1903, vol. ii, p. 863). A similar proportion was observed in 1,948 cases reported by J. Alison Scott from the Pennsylvania Hospital; thus, 153 deaths in which were 48 perforations (*Univ. of Penn. Med. Bull*, 1905–6, vol. xviii, p. 81); and by Goodall in the Eastern Fever Hospital (*Lancet*, 1904, vol. ii, p. 9); thus, 1,921 cases, with 304 deaths, in 96 of which were perforations, all the patients dying but two.

Indications. These are of the same nature as in other pathological perforations, but they differ somewhat in their relative importance, and tend to be obscured by the coexistence of the severe symptoms of the primary disease.

Operation. The patient is placed in the supine position, and a subumbilical incision 4 inches in length is made through the right rectus sheath, exactly in the same manner as for dealing with an appendix in which pelvic suppuration is suspected. This incision has the great advantage of allowing subsequent drainage for a time, without the ulterior development of a ventral hernia (see p. 495).

The abdomen open, an immediate escape of sero-fibrinous exudation or possibly free gas may occur. If this be not the case, search for the perforation is commenced by finding the ileo-cæcal junction, and carefully following the gut in an upward direction. This part of the search should be made with circumspection, as the position of escape of gas or fluid is a valuable localizing indication of the site of perforation. In some 90% of all cases the latter will be found in the ileum within 2 feet of the ileo-colic valve, and in nearly four-fifths of the ileal cases within the first foot. In 264 cases collected by Hector Mackenzie (*loc. cit.*, p. 864) 2 perforations were seated in the jejunum, 232 in the ileum, 22 in the large gut, and 9 in the vermiform appendix. Fluid and escaped intestinal contents are mopped up with gauze sponges as the search proceeds, the possible situation of the perforation in the cæcum or the vermiform appendix being excluded or verified, as the case may be, at the commencement of the exploration. Adhesions rarely give rise to any trouble, as the operations are often performed at an early stage; and even when the perforation has existed longer, the deposition of plastic matter capable of localizing diffusion, as in appendix perforations, is rare, probably from

the bad condition of the patient and consequent want of proper reaction on the part of the peritoneum.

The perforation may be one of two varieties; either a small opening at the free margin of the bowel, from about the size of a pin's head to ¼ of an inch in diameter, forming the deepest part of the base of an ulcer, or an area sometimes involving the whole circumference of the bowel, may be the seat of a gangrenous cellulitis, one or more openings existing within the necrotic area (see Fig. 171). When the openings are of the small variety they are usually single, but it is not uncommon to discover one or more incipient perforations, the site of which is indicated by the presence of a small yellow area in the near neighbourhood of the complete one.





FIG. 171. TWO PIECES OF ILEUM FROM A CASE OF ENTERIC FEVER. In the upper is seen a perforation shelving from within; in the lower a large slough is seen in the process of detachment, and several depressions from which sloughs of varying depth have separated. (*St. Thomas's Hospital Museum*, No. 1044.)

Should the search in the lower ileum prove fruitless it must be borne in mind that perforation may exist in the ascending, transverse, or even descending colon; also that in colic perforations there is more tendency to the formation of multiple openings.

When the perforation has been found. there is often room to apply clamps on either side of it, in order to prevent further escape of contents during the process of suture. This procedure is often unnecessary, as escape is not free and the opening small. The surrounding area is mopped as dry as possible, and it may be a convenience at this stage of the operation to raise the foot of the table to facilitate the packing away and retention of the intestines during the process of suture.

Small perforations may be closed by the introduction of a single mattress stitch, the closed spot being further sunk by a few Lembert's sutures passed in the transverse axis of the bowel. The same procedure must be adopted should incipient perforations be noted in the neighbourhood of the complete one. In larger perforations a through and through suture should be used, but again the mattress form of suture affords the firmest hold. In the rarer cases in which a large necrotic area

is found, it may be necessary to perform an enterectomy, care being taken that the portions of bowel to be united are free from ulceration.

Perforations of the vermiform appendix are treated by removal of the same in the type manner, and the same course should be taken in the rare cases in which the perforation is situated in a Meckel's diverticulum. It should be borne in mind that suppurating mesenteric glands are occasionally met with in patients the subjects of perforation.

Should doubt exist as to the efficiency of the suture the perforation is usually so situated as to readily allow the application of an omental graft. In the right iliac fossa it is also possible to suture the omental apron in such a fashion as to shut off the greater part of the upper abdomen and even the pelvis, in order to minimize the dangers of possible ulterior leakage.

Lastly, should the bowel-wall be in such condition as to make the introduction of sutures futile, the last resource of establishing an enterostomy may be adopted, although with small hope of ultimate success.

The process of suture completed, attention is turned to the final cleansing of the peritoneal cavity. The sutured bowel itself, and the immediate neighbourhood, may be washed with normal saline solution; wider spread peritoneal exudation is better absorbed by dry gauze strips carefully introduced in all directions where its presence is suspected. The area of peritoneum most severely inflamed will be situated in the pelvis, and here intestinal contents will be most likely to have gravitated. A drain must always be introduced, since there is no chance that either the escaping intestinal contents or the consequent reactionary peritoneal exudation will be sterile, as in the case of a duodenal perforation. The bacillus coli-communis is usually present, and sometimes pyogenic cocci. A large india-rubber tube passing to the bottom of Douglas's pouch, supplemented by a gauze drain in one strip, so introduced as to be most ample in the right iliac fossa as deep as the pelvic brim, and emerging by the abdominal wound, is the most satisfactory form of arrangement. By this means both the capillary action of a gauze drain and the advantage of the more permanent channel afforded by a tube are obtained.

The wound is closed, leaving sufficient space for the withdrawal of the gauze drain, which latter process should be commenced on the second day, and be completed on the third or fourth.

Prognosis and results. When the general condition of the patients on whom this operation has to be performed is borne in mind, the recorded results are surprisingly good, and support the view originally advanced by von Mikulicz, that patients in whom a perforation is suspected should undergo an exploratory operation. Experience, however, has shown this course to be open to considerable danger. Harte and Ashurst (*Ann. of Surg.*, 1904, vol. xxxix, p. 39) give details of 26 cases in

which the abdomen was opened and no perforation discovered, of which number 10 subsequently died. This mortality cannot be entirely attributed to the operation, since the latter has often to be undertaken in desperate cases of a disease which itself possesses a general mortality of 13–14 %, but it suffices to give a useful caution against a too free resort to exploration.

Recovery is usually slow, and the occurrence of both general and local complications is common; thus, exhaustion from the fever itself, pneumonia, secondary abscesses, iliac thrombosis, &c. The existence of coexisting intestinal hæmorrhage is a very bad prognostic element. The prognosis is naturally best in operations undertaken during the first twenty-four hours, and also in patients between ten and twenty years of age. Elsberg (*Ann. of Surg.*, 1903, vol. xxxviii, p. 71) has published 25 cases of perforation in children with 9 deaths, a mortality of only 36%. Sydney R. Scott records 9 cases operated upon at St. Bartholomew's Hospital (*St. Barts. Hosp. Rep.*, 1903, vol. xxxix, p. 131), including the first successful suture performed in London by Bowlby, with 5 deaths, mortality 66 6%. J. Alison Scott (*loc. cit.*, p. 86) records 39 operations performed at the Pennsylvania Hospital with 27 deaths, mortality 69·2 %. Harte and Ashurst (*Ann. of Surg.*, 1904, vol. xxxix, p. 8) report 362 collected cases with 268 deaths, mortality 74%. Zesas (*Wiener Klinik*, 1904, vol. xxx, p. 317) records 255 operations with a mortality of 66%.

Zesas's statistics include 142 cases of simple suture with 89 deaths, mortality 62·6%; also 20 enterectomies with 12 deaths, mortality 60%. This would appear to show a margin in favour of the more radical method of enterectomy, but it must be remembered that the patients in whom it would be considered safe to undertake an enterectomy, are those whose general condition is the more promising at the time of the operation. Murphy reports 5 consecutive operations and recoveries (*Surg. Gyn. and Obst.*, June, 1908, p. 565).

The general results have therefore improved since the publication of Keen's list of 83 cases with 67 deaths, mortality 80·7% (*Surg. Compl. and Seq. of Typhoid Fev.*, 1898). Collected results gleaned from various sources are, however, open to the usual defect of statistics thus obtained, of not including the large number of unsuccessful cases remaining unrecorded, and against the numbers given above may be quoted those of Goodall (*Lancet*, 1904, vol. ii, p. 14), who reports four recoveries only in 49 operations performed at the Metropolitan Fever Hospital, mortality 91·8%.

PERFORATIONS OF AN INFECTIVE AND INFLAMMATORY NATURE

Such perforations are met with in their simplest form in the case of loops of bowel implicated in internal or external herniæ, then usually on the free convex margin of the bowel. They require to be sutured with

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CHAPTER VIII

ENTEROTOMY AND ENTEROSTOMY

THE terms enterotomy and enterostomy naturally include operations on any part of the whole length of the intestinal canal. It has, however, long been customary to designate openings into the colon under the terms colotomy and colostomy, while later the convenient custom of specially designating any enterostomy by a name corresponding to the part of the tube opened has become general.

Indications. These operations have a somewhat wide application, either as temporary or permanent measures, and may be indicated under very varying circumstances.

(i) Enterotomy is employed as a convenience during the performance of operations where intestinal distension interferes with the necessary manipulations. When the bowel is in good condition, and readily contracts after the evacuation of its contents, the opening may be at once closed.

(ii) In other instances, when intestinal fermentation has reached an advanced stage, and either the muscular contractility of the bowel has suffered severely from the action of the toxins on the nervous plexuses (Barker), or from continued distension when in a septic condition, an enterostomy for a short period is often advantageous. Under these circumstances an enterostomy not only relieves the bowel-wall, but also allows nutriment to be introduced into the distal segment of the bowel.

(iii) In a similar manner a jejunostomy may be established to nourish the patient, and relieve the general condition, antecedently to the performance of a gastro-enterostomy.

(iv) In the large intestine an enterostomy may be used as a temporary measure prior to the removal of growths of the bowel, for purposes of lavage in morbid conditions of the colon, or as a safety-valve to prevent the collection of gas and fæcal matter in the case of short circuiting.

(v) Lastly, in one or other of the forms of colostomy, the issue of the fæces may be permanently diverted to a new aperture.

some care, since the surrounding area is not so much the seat of inflammatory induration, as of defective vitality due to infection and distension of the intestinal wall dependent on interference with the blood-supply. Such sutured spots may remain weak and form the site of recurrent perforations; thus, an old woman, in whom a perforation was closed during the performance of an operation for strangulated femoral hernia, came again under treatment six months later for general peritonitis due to recurrence of ulceration at the sutured spot, the silk stitches of the former operation being found still in position on one margin of the opening.

PERFORATION OF STERCORAL ULCERS AND IN DIVERTICULAR DISEASE

Acute perforations of either nature are generally only diagnosed during an exploratory operation; they occur usually in subjects of chronic constipation, who are suddenly seized with symptoms of acute peritoneal infection closely simulating those of acute obstruction. The ulcers are situated in some portion of the colon, the diverticula, especially in the sigmoid flexure. Perforation of a diverticulum frequently results from the presence of a stercolith. If practicable, the opening should be closed by suture, and the peritoneal cavity closed and drained. In diverticular disease, when distal obstruction exists, it is advisable to make a proximal colostomy in addition. The ultimate prognosis in these cases is bad.

When the process of perforation is subacute or chronic, localized suppuration results; here incision and drainage form the immediate treatment, to be possibly followed in diverticular disease by colectomy (see pp. 426–52).

PERFORATION IN MALIGNANT DISEASE

This condition offers little scope for credit to the operating surgeon. When the perforation is acute the majority of the patients die from acute peritoneal infection, whether operated upon or not. None the less, when brought into the presence of one of these cases the position of the surgeon is one of some perplexity. Laparotomy offers slight chance of recovery, and if no operation is decided upon the patient must be kept under opiates to relieve the misery which continues until death. If laparotomy be decided upon, closure of the opening should be accompanied by the performance of a proximal colostomy or unilateral exclusion, to divert the course of the fæces. Under these circumstances, if the patient be in good condition, and is dealt with within a few hours of the occurrence of the accident, a recovery may occasionally be obtained, and in any case the sufferings of the patient may be very materially relieved.

this is sunk by the addition of a transverse line of Lembert's stitches, involving the serous and muscular coats.

The exposed loop is now thoroughly cleansed by washing with warm normal saline solution and returned.

ENTEROSTOMY

Operation. In cases where the wall of the bowel has suffered so much as to lose its tone and contractility, the incision in the bowel may be employed for the purposes of a temporary enterostomy. For this object it suffices to tie in a Paul's tube, and fasten the bowel in a lower angle of the wound with a few stitches; two, one at either end of the loop of bowel, will usually suffice. In using the Paul's tube for this purpose it is important to pass the retaining purse-string suture close to the margin of the wound in the bowel, including as little of the bowel-wall as can be safely employed, in order that the resulting loss of substance shall be as small as possible. If this precaution be taken, a lateral enterostomy opening only results, which, if it does not close spontaneously, may be occluded with ease by suture later. (See Closure of fæcal fistulæ, p. 483.) A temporary enterostomy of this nature, made in cases where the distension has been above a mechanical obstruction, and where the bowel below is in good condition, may be of considerable use later as a means of introducing nourishment in the early stages of the further treatment of the case.

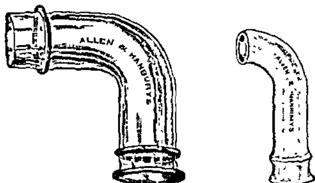


FIG. 173. PAUL'S ENTEROSTOMY TUBES.

In certain positions, *i.e.* the upper end of the small intestine, a permanent enterostomy for purposes of nourishing the patient is occasionally employed. In these operations, which are founded upon an exactly opposite principle to the so-called artificial anus, the object to be striven for is the prevention of the escape of intestinal contents, and, as might have been expected, the technical experience attained in perfecting the corresponding operation of gastrostomy has been freely drawn upon.

ENTEROTOMY

Operation. When enterotomy is used as a purely temporary measure its performance is one of great simplicity. A coil of bowel is drawn as far as practicable out of the wound, thoroughly surrounded by gauze plugs to protect the abdominal cavity, and then punctured.

In some cases where a single coil, as the sigmoid flexure, is locally distended, it may suffice to first introduce a purse-string suture, and in the centre of the included area to enter a large trochar and canula to evacuate the contents, which are often in a large measure gaseous. A rubber tube may be fitted to the canula to allow of the contents being collected in a vessel well away from the field of operation. When the coil is emptied the suture is tightened up as the canula is withdrawn, and the tied purse-string suture is sunk by the introduction of a short transverse line of Lembert's stitches.

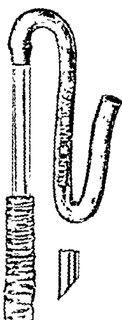


FIG. 172. MOYNIHAN'S INTESTINAL DRAINAGE TUBE.

When distension is more general, and a longer stretch of intestine needs to be emptied, it is preferable to make an incision with the knife, and several of these may be needed. In order to avoid multiple incisions, Moynihan employs a piece of glass tubing some 6 or 8 inches long, to which is applied a piece of india-rubber tubing to carry the intestinal contents well away from the area of the wound (see Fig. 172). When the contents in the immediate neighbourhood of the opening have escaped, the glass tube is introduced in nearly its whole length, a piece of gauze is wrapped around the point from which the tube emerges to prevent escape by the side, and it is entrusted to the hands of an assistant. The surgeon now slowly, and with care, draws on to the tube the intestine beyond; in this way as much as 8 or 10 feet may be brought into the field of operation and thoroughly emptied.

Moynihan further makes use of this tube either for washing out the intestine with saline solution, introduced by a hollow needle provided with a funnel and rubber tube, entered at the highest point to which the tube has penetrated, or, in certain cases, for the introduction of solution of sulphate of magnesia.

When the enterotomy opening has served its purpose, an inner line of suture, including the whole thickness of the bowel, is introduced, and

Operations. A paramedian incision, with displacement of the rectus outwards, is made, and the great omentum drawn up and pushed to the right. (Near the median line the above plan is preferable. A separation of the fibres of the right rectus for the permanent opening may be made when the muscle returns into position if desired.) The index-finger of the left hand is next passed along the under surface of the transverse mesocolon to the spine, and the finger hugging the left side of the second lumbar vertebra hooks up the commencement of the jejunum, which is brought into the abdominal wound. The bowel is then tested to make sure that one extremity of the loop is fixed, and the subsequent

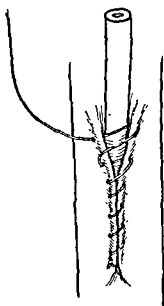


FIG. 174. JEJUNOSTOMY. Tube inserted by Witzel's method.

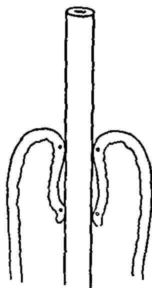


FIG. 175. JEJUNOSTOMY. Kader's method.

steps of the operation are proceeded with according to which method of arrangement and fixation is determined upon.

The simplest method is that of *von Eiselsberg*, who in 1895 modified the plan introduced by Witzel for gastrostomy. Two folds are raised on the wall of the intestine by the introduction of a Lembert's suture, including the serosa and muscularis, which marginate a groove in which a No. 10 rubber catheter can lie (see Fig. 174). At the distal end of this groove an opening is made and the tube pushed deeply into the lumen of the intestine. The Lembert's suture is now tightened, reinforced by the introduction of a few stitches beyond the point of perforation, and the intestine sutured to the parietal peritoneum in such a way as to lie transversely to the long axis of the abdominal wound. The external opening should be about on a level with the umbilicus.

DUODENOSTOMY

Bearing in mind the object of these operations, it is natural that the duodenum should have been chosen as the most fitting site for the fistula, since the nourishment can be here introduced above the point of entrance of the biliary and pancreatic secretions, and some addition at least of the gastric secretion may be looked for ; hence the conditions approach the normal as far as possible. Experience has, however, shown that although the anatomical conditions allow the approximation and fixation of the duodenum to the abdominal wall without great trouble, yet the resulting fistula is exceedingly difficult to manage, escape of the secretions frequently occurring. Hence this operation, although theoretically advantageous, has found little favour, and, in spite of the able advocacy of Hartmann, is seldom performed. Moreover, the technique of the operation of jejunostomy has been so much improved, that the latter may be said to offer practical advantages little inferior, even in theory, to those claimed for duodenostomy.

JEJUNOSTOMY

This operation was first performed by Surmay of Ham in 1878, as a means of dealing with a case of inoperable gastric carcinoma; that is, at a period prior to the introduction of gastro-intestinal anastomosis, an operative procedure which has rapidly restricted the employment of jejunal fistulæ as a route by which nourishment can be afforded to subjects of pyloric obstruction. Conditions are met with, however, in which the procedure is still applicable, although the success attained by it has not brought many enthusiastic supporters to the method.

Indications. Jejunostomy may be resorted to under the following conditions :—

(i) It may be employed in cases in which the coats of the stomach have received serious damage from the ingestion of caustic fluids, to ensure rest during the process of healing.

(ii) In certain cases of gastric or œsophageal carcinoma, where the stomach is so contracted as to render gastrostomy impracticable. With regard to this indication it may be pointed out that since gastrostomy has been resorted to at an earlier date, such contractions of the stomach are far from common.

(iii) In cases of pyloric carcinoma, where the extent of the growth makes an anastomosis an impossibility.

(iv) Its employment has also been advocated as a means of securing physiological rest for the stomach in some cases of gastric hæmorrhage (von Mikulicz), or even in functional disorders (von Eiselsberg).

Maydl's method is well devised for the prevention of the escape of the biliary and pancreatic secretions, while these fluids are also added to the nutriment given subsequently to its introduction, and thus the natural conditions pertaining to a duodenostomy are reproduced. The objection to the method is that its performance necessitates considerable expenditure of time, while the patients on whom the operation has to be performed are often in the last degree of exhaustion.

In *Albert's method* a loop of jejunum is well drawn out, and a lateral anastomosis is established at its base (see Fig. 177). After the loop has been drawn through the fibres of the rectus, and its base attached to the parietal peritoneum, an opening is made at its apex and a tube tied in. The tube in this case may well be fixed in by the double purse-string or 'inkpot' method.

The operation of jejunostomy has not been very warmly taken up in this country, and it does not appear likely, in spite of the commendation it has received from Maydl, von Eiselsberg, and others, that it will gain much ground. A consideration of the indications set forth shows that only in the rare cases of entire abolition of the cavity of the stomach can it be looked upon as the sole resource, while further experience is necessary before it can be recommended as a means of giving rest to the stomach. It has been claimed that the operation is slight, may be performed with local anæsthesia, that it can be employed in cases of carcinoma of the stomach in which the condition of the patient renders the risk of an anastomosis unjustifiable, and that it affords absolute rest to the stomach, which is not the case after an anastomosis. Further, that a jejunal fistula, by resting the pylorus, reduces the spasm of that sphincter and allows an increase of the amount of food which can pass by the normal route, hence it is employed as an antecedent to anastomosis by some surgeons. In a series of twenty-five cases reported from Garre's clinic by Loyel, the average duration of life after the operation amounted to eighty-seven days.

Of the four methods it is clear that physiologically Maydl's is the most perfect, but when the condition of the patients in whom this operation is indicated is taken into consideration, one of the simpler will usually be selected. Moynihan has devised and recommends an operation similar to von Eiselsberg's, while Mayo Robson recommends one on the principle of Albert's.

APPENDICOSTOMY

There are several conditions under which this operation is applicable.

Indications. (i) The canal of the vermiform appendix may be employed for the provision of a safety vent in cæcal distension, or to serve as a route for lavage, or for the introduction of medicaments into the large

Another simple method, *Kader's*, is founded on the gastrostomy of Fontan and Senn. An opening is made in the centre of an area surrounded by a purse-string suture, and the tube is secured in the opening made into the bowel by tightening and tying the suture. A second area is now enclosed by a further purse-string suture, the catheter pressed in to invert the bowel-wall between the two sutures, and the second string tied (see Fig. 175). The shoulder projecting around the tube is sutured to the parietal peritoneum and fascia transversalis at the lower angle of the abdominal wound, and the latter closed.

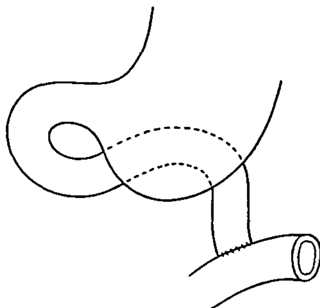


FIG. 176. JEJUNOSTOMY. Maydl's method.

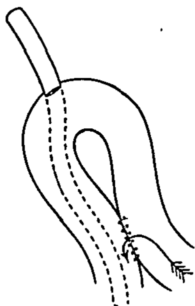


FIG. 177. JEJUNOSTOMY. Albert's method.

Two other methods in which the aid of an anastomosis is invoked should be mentioned.

In *Maydl's method* the loop is well drawn out, and after the application of clamps, the intestine is completely divided, the incision passing from 4 to 5 inches into the mesentery.

The lower portion is now sufficiently drawn out of the abdomen to allow of the application of a third clamp some 6 inches down at its convex margin. Above this clamp an incision 1¼ inches in extent is made at the free margin of the bowel, and into the opening thus made the lower end of the proximal portion of the bowel is implanted (see Fig. 176).

The free open end of the distal portion of the jejunum is now drawn into the wound and so fixed as to allow the projection of some ¾ inch beyond the skin. This portion of the bowel, which is to serve as the permanent fistula, may be drawn obliquely through an opening in the right rectus obtained by separation of the muscle fibres.

been fixed, as has been done in the cases of some enterostomies in other portions of the bowel, by the passage of a couple of safety-pins. In anchoring the appendix, care should be taken that neither the tube nor its mesentery be damaged or unduly pressed upon, as in some instances undesirable sloughing has resulted from one or other of these causes. The tip of the appendix, or a convenient portion, is removed in the course of two or three days.

COLOTOMY AND COLOSTOMY

The operation of simply incising the colon is rarely undertaken except for the temporary reduction of distension during the performance of an operation. That of colostomy, on the other hand, is performed with great frequency in spite of the limitation of its field of application which has attended the improvement in methods of intestinal anastomosis.

Two factors in particular have served to increase both the popularity and success of the operation: firstly, the practical abandonment of the lumbar route, adopted in preaseptic days as a means of avoiding the risk of opening the peritoneal cavity; secondly, the introduction by Paul of the tube which bears his name, which has rendered it possible to open the bowel with ease and safety at the same time that it is exposed.

Opinions still differ as to the degree of comfort enjoyed by the patient after the performance of colostomy, and it must be allowed that the procedure is perhaps held in more favour by the operating surgeon than by the general practitioner, whose duty requires him to guard his patient to the end. With regard to this unpopularity, however, the forms of disease for which the operation is most commonly undertaken must undoubtedly take the chief blame, for in those cases in which colostomy is performed for conditions other than malignant disease the patient may live many years in comfort, and suffer little inconvenience from the artificial anus. A colic anus ensures the proper evacuation of the segment of the bowel lying above an obstruction, with consequent relief from the dangers of auto-intoxication, and those attendant on ulceration either of the distended bowel above the growth, or of the growth itself.

The patient is relieved from much pain, but in this particular it is necessary to discriminate as to the cause of the symptom; one of the most distressing forms, that due to flatulence, may be certainly relieved, also pain due to the passage of fæces over an ulcerated surface; but when pain of the neuralgic character, which indicates the implication of neighbouring bones or nerves, is present, the surgeon must be wary as to how far he promises relief to the patient.

Again, with regard to the diminution of discharge; an efficiently performed colostomy, which thoroughly eliminates undue retention of

intestine, as proposed by Weir. The operation has found very considerable favour, no doubt in great measure on account of the ease with which it may be performed, and the neatness of the procedure.

Where a safety vent alone is required it has proved a satisfactory measure, since the fistula is easily maintained, easily closed, and, as a result of the facts that the normal direction of the peristalsis is towards the interior of the bowel, and of the valvular nature of the opening, it gives rise to no inconvenience by allowing the escape of the cæcal contents. Moreover, it has been shown that when the fistula requires to be used for lavage, the patient can be entrusted with the performance of the same.

(ii) As to the employment of the operation in cases of colitis, the measure of success to be expected must differ with the character of the disease. In simple mucous or membranous colitis it is an operation of minor severity, and appears to possess the great advantage over a lateral colostomy in the ascending colon of not closing spontaneously. In severe ulcerative colitis, where the benefit to be derived from the colostomy depends not upon the possibility of lavage, but on the complete diversion of the flow of fæces, no advantage can be gained by its employment.

(iii) The application of the operation has been greatly widened since its first introduction; thus, to the treatment of amœbic dysentery, and even of enteric fever, as a means of evacuating stagnating intestinal contents from the proximal side of the ileo-cæcal valve (Ewart).

(iv) Keetley (*Proc. Roy. Soc. of Med.*, vol. ii, Sec. of Surg., p. 67) has employed the appendical canal as an actual artificial anus in a case of malignant disease of the colon successfully, and he claims that the capacity of the appendix for dilatation warrants its use for this purpose.

(v) The operation has also been performed to allow of lavage in cases of chronic constipation of intractable nature. The good effect is often temporary.

(vi) Lastly, an appendicostomy opening has been employed for the introduction of fluids and nutriment into the cæcum and lower end of the ileum.

Operation. The operation is best performed by following the early stages of the procedure described for the removal of the appendix by McBurney's method (see p. 494). The appendix having been freed, it is brought either directly through the centre of the wound, or a small special opening may be made for its passage between the fibres of the internal oblique and transversalis muscles, at the lower end of the opening in the external oblique aponeurosis.

The appendix may be secured at its base by a few sutures; or it has

or ulceration of the colon or rectum (*e.g.* tubercle and dysentery), for the diversion of the fæces and the lavage and application of medicaments to the bowel.

The treatment of ulcerative colitis by colostomy has become a somewhat frequent measure, and in considering this disease as an indication it is necessary to use some precision as to what is aimed at. Is the primary requirement that of an opening to allow of lavage and local applications to the bowel? or is the diversion of the fæces the primary object? There seems little doubt that here, as in many other instances, writers on this subject have somewhat obscured the question by dealing with cases of a very different nature under the same general heading. In cases in which the prominent symptoms are diarrhœa, the passage of mucus and blood in large quantities, fever, and rapid emaciation, there can be no doubt that diversion of the fæces is the first object to be aimed at, and that unless this be complete no advantage will accrue from the operation. Again, that in some cases in which pain, amounting to such a degree as to cause actual attacks of collapse, is the main feature, diversion of the fæces affords the only likelihood of relief.

In obstinate cases of mucous colitis, the complete diversion of the fæces is not so much the primary object, as the possibility of the direct treatment of the interior of the bowel by lavage and the application of various medicaments. Here, therefore, a lateral fistula into the colon, which is easy of closure, or an appendicostomy, meets the requirements. The same remarks apply to the treatment of amœbic dysentery, in which satisfactory results by these measures have been obtained in severe cases.

In true ulcerative colitis a complete colostomy is required, although *performed in the anticipation of ultimate closure.* This latter question of closure is fraught with grave difficulties, partly as to the suitable moment at which it should be undertaken, and partly from the danger to life with which the procedure is attended.

In some cases the beneficial effect of diversion of the fæces is prompt; the hæmorrhage and auto-intoxication from the ulcerated bowel are completely checked, and in the course of from three to six months the question of closure of the artificial anus may be safely considered. Many such cases have now been recorded, but in the experience of the individual surgeon they are none too common. A considerable improvement persists so long as the artificial vent is maintained, but the attempted closure of this is often followed by either the recurrence of symptoms or the death of the patient.

Further experience and improved methods of treatment, local and general, may render it practicable to lay down definite rules as to the period after which it is safe to attempt to close an artificial anus in this

intestinal contents, at the same time tends to cure the catarrhal colitis, which is the main source of the offensive mucus, which forms a large proportion of the frequent stools; but where the source of the discharge is rapid degeneration and disintegration of a malignant growth, little is to be looked for in this particular from a colostomy, and the same remarks are pertinent in the case of hæmorrhage.

The colon may be opened in any part of its course, but since the left lumbar operation has fallen into disfavour, occasions on which the descending colon are opened, except at its lowest part, or junction with the sigmoid flexure, are rare, since the depth at which this portion of the bowel lies from the surface, and the practical absence of any mesentery, render it unsuitable for the formation of a satisfactory anus. The same difficulties, in a lesser degree, attend the formation of a colostomy opening in the cæcum and ascending colon, and here it may be impossible to perform other than what is known as lateral colostomy, *i.e.* an opening in the wall of the colon without the formation of an efficient spur. These openings are unsatisfactory for two reasons: firstly, they allow the passage of fæcal contents into the distal segment of the bowel, and, secondly, they have a strong tendency to contract and close spontaneously. Where the opening is intended to be of a temporary nature this is of little importance, and indeed may sometimes be an advantage, but when a permanent complete diversion of the fæces is needed, such operations rapidly prove themselves unsatisfactory or useless.

Indications. (i) To afford a permanent artificial anus in cases of malignant growth of the rectum or pelvic colon, either alone or in combination with removal of the growth itself.

(ii) As a temporary expedient to relieve the obstruction due to the presence of a malignant or other stricture of the bowel, prior to radical treatment of the obstruction itself by colectomy.

With regard to these indications, some remarks will be found elsewhere as to the performance of colostomy in carcinoma and other conditions of the rectum (see p. 685); it suffices simply to point out here that colostomy is suited for some cases and not for all, and that the indiscriminate application of the operation in such diseases has been the most potent factor in such discredit as pertains to the operation.

(iii) As a temporary measure in cases in which obstruction is acute and accompanied by much distension, and due not to growth or stricture, but to the kinking of the bowel either by the tension of a normal band (*e.g.* costo-colic ligament at the splenic flexure) or by an abnormal adhesion.

(iv) A temporary colostomy may be rarely needed in cases of volvulus accompanied by great distension above the affected loop or loops.

(v) As a temporary measure in the treatment of some forms of colitis,

or ulceration of the colon or rectum (*e.g.* tubercle and dysentery), for the diversion of the fæces and the lavage and application of medicaments to the bowel.

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Further experience and improved methods of treatment, local and general, may render it practicable to lay down definite rules as to the period after which it is safe to attempt to close an artificial anus in this

disease. A glance at Fig. 178 shows the condition which may exist in cases of any standing prior to the performance of the colostomy. When general and local symptoms have subsided, a preliminary examination with the sigmoidoscope, both from the natural and the artificial anus, may afford help as to the condition of the interior of the bowel, and this examination should be supplemented by the introduction of a Mitchell Banks's tube to observe the result of diversion of the fæces into the portion of the normal channel which has been excluded. If these tests afford satisfactory results, the closure of the anus may be attempted.



FIG. 178. ULCERATIVE COLITIS. Irregular ulceration exposing the muscular coat. The remaining mucous membrane forms undermined and tumid islands. (*St. Thomas's Hospital Museum*, No. 1077.)

It must be borne in mind that the portion of bowel excluded after a time undergoes a process of cicatrization as well as contraction, which may render it quite unfit for purposes of anastomosis as a preliminary to closure of the artificial anus. When the bowel has been excluded for six months or more it may contract to such an extent as to resemble a tape, its wall assumes a singularly pale bloodless aspect, while the appendices epiploicæ gain a very large size, resembling considerable fatty tumours. Beyond this the tissue is brittle and friable and quite unsuitable for the safe introduction of sutures. In these particulars the contracted bowel is very different from that met with when the excluded portion of the colon is itself healthy, and should they be revealed by an abdominal exploration, the case is probably not only unsuited for the establishment of an anastomosis, but also for closure of the artificial anus.

(vi) The existence of a fistulous communication between the bladder and the rectum.

(vii) Obstruction due to pressure on the bowel from without, most frequently by pelvic tumours. Most commonly the source of obstruction is in connexion with disease of the female generative organs; less frequently, a tumour, springing from the pelvic wall, may be the source of pressure.

(viii) Certain congenital malformations of the lower end of the alimentary and genito-urinary tracts.

(ix) Occasionally spontaneous perforations of the colon from malignant or other disease, or injury to the bowel, especially on its extra-peritoneal aspect.

LUMBAR COLOSTOMY

The important part played by lumbar colostomy in the development of modern methods of enterostomy and the treatment of intestinal obstruction renders it almost impossible to exclude all mention of the method in a textbook of operative surgery. Many reasons, however, have led to the almost complete fall into desuetude of the operation; indeed it is difficult to lay down definite indications for its choice, a right lumbar colostomy as a substitute for a cæcostomy being almost the only situation in which the alternative measure can receive serious consideration. The practical disadvantages of the method are sufficiently obvious; the loin may be deep, or the space between the last rib and the iliac crest narrow, the gut itself when contracted may not be easily detected, the presence of a mesocolon may increase the difficulty of performing an extra-peritoneal operation, or as a result of congenital peculiarity the colon may not occupy its normal position. The presence of ascites may cause the peritoneum to bulge and obscure the colon, or an enlarged or abnormally-placed kidney may interfere both with the exposure of the bowel and its fixation to the surface. Again, the wound gives little scope for exploration, and affords no elasticity for further procedures if any of the enumerated difficulties be met with, or, if it should be found that growth actually occupies the situation destined to be the site of the artificial anus, the resort to a second incision in the right lumbar region could hardly be faced with equanimity at the present day merely for the advantage of an extra-peritoneal operation, so greatly valued by surgeons in bygone times. Lastly, the lumbar artificial anus is so situated as to be in a less convenient position than one in the iliac region.

CÆCOSTOMY, TYPHLOSTOMY, ASCENDING COLOSTOMY

The cæcum and commencement of the ascending colon are more frequently utilized as the seats of temporary than permanent colostomies. Thus this portion of the colon is sometimes opened in cases of obstruction due to stricture or growth of the ascending or transverse colon, where great distension exists, as a preliminary measure to further treatment when the distension shall have subsided. Again, the intestine is often opened in this position in case of ulcerative colitis.

The operation has always been unpopular for obvious reasons, the most important of which is the tendency of the resulting intestinal discharge to cause irritation of the surrounding skin; this trouble, although more marked in some cases than others, may be looked upon as a constant one. With regard to the consistence of the matter discharged from a cæcal anus, however, it may be pointed out that it by no means necessarily retains its primary fluid character. With time the fæcal matter tends to acquire more consistence and becomes less irritating; thus the condition in some degree conforms with what is seen in iliac colostomies, where the patients with time acquire very considerable regularity in the occurrence of actions of the bowels. A second objection, the loss of nutrition due to the early escape of the intestinal contents, is also a real one, but not of so marked a nature. It has been shown that patients with a cæcal anus may live for a considerable time, gaining flesh, and not unbearably uncomfortable. Thus two cases are recorded by Messrs. Goodsall and Miles, in one of which the patient had lived nine years, putting on 25 lb. in weight, and another six years, during which the weight increased 10 lb.

It cannot, however, be too strongly laid down, that the disadvantages resulting from an artificial anus in this situation steadily and rapidly decrease with every inch that the opening can be advanced towards the anus. It is well known that the tendency is for a certain stagnation of the intestinal flow to take place when the cæcum is reached, and that the fluid constituent is freely absorbed, and this fact has an important bearing on the consistence of the matter discharged. Moreover, with an ascending colostomy the direct transverse flow of small intestinal contents from the ileo-colic valve to the artificial anus is avoided. In cases of colostomy for ulcerative colitis in which it may be necessary to maintain the artificial anus for very considerable periods, these points are of special importance, and the anus should not be established below the level of the ascending colon

Operation. *The lines of operation are the same* whether the cæcum or the ascending colon is to be the site of the colostomy.

If the conditions allow the ascending colon to be employed, an incision similar to that for appendicectomy by McBurney's method may be used. The question then arises whether the muscular fasciculi should be separated or divided across their course, and in this relation it should be remembered that a lateral colostomy is often either all that is, or can be, aimed at. Hence, considering the known tendency of such openings to contract and close spontaneously, it is better to divide the muscles to an extent of at least 2 inches. If this course be taken, in spite of the disposition to contract possessed by the opening of the bowel,

considerable prolapse of the mucous membrane often occurs with the lapse of time, and the patency and efficiency of action of the artificial anus increases.

After the incision of the peritoneum, no difficulty usually presents itself in at once dealing with the colon which lies directly beneath the wound. The parietal peritoneum, together with the fascia transversalis, should be carefully sutured to the surface of the cæcum or colon, a proceeding which may necessitate some enlargement in the wound in the abdominal wall, and the external wound having been suitably reduced in size by the introduction of sutures, the bowel may be left to be opened two or three days later. When it is imperative to relieve the distension at once, the bowel must be drawn as prominently as possible into the wound, the central area is surrounded by a purse-string suture, within the limits of which an incision is made, and a Paul's tube is inserted.

In cases of obstruction the cæcum may be enormously distended, and the removal of the support previously afforded by the intact abdominal wall may be followed by the occurrence of distension rents of the peritoneal covering of the bowel. Under these circumstances great gentleness is required in the manipulation of the intestine, lest a rupture and escape of fæces should occur. The same condition may make the introduction of sutures, without perforation of the bowel-wall, very difficult, but every effort must be made to avoid this complication.

When the ascending colon is selected, the conditions may permit the bowel to be sufficiently mobilized for the introduction of a glass rod across the mesenteric aspect, if a complete colostomy be preferred. For this purpose it may suffice to divide one or more of the folds which frequently pass from the outer aspect of the colon to the abdominal parietes, or if these are not present a small vertical incision may be made through the parietal peritoneum just beyond its reflection from the bowel to the abdominal wall. In either case care must be taken not to compromise the integrity of the colic vessels.

TRANSVERSE COLOSTOMY

This operation offers some technical advantages over that upon the ascending colon, in that the length of the transverse mesocolon makes the performance of a complete colostomy an easy matter. The operation may often be utilized as a temporary measure in dealing with acute obstruction in the bowel beyond, and the transverse colon may sometimes be made use of in inguinal colotomy where the shortness of the mesosigmoid prevents the satisfactory extrusion of the sigmoid flexure (see p. 417). Unfortunately, transverse colostomy is seldom applicable

to cases of ulcerative colitis, since the operation fails to fulfil the important indication of relieving as far as possible the whole colon from the duty of conducting the fæces.

Of late years there has been a tendency to extend the employment of this method, and the following advantages have been claimed for it: A complete colostomy is always possible; the position of the anus allows it to be readily employed by the patient by simply leaning forward over a suitable receptacle; the situation of the opening allows the separated fibres of the rectus abdominalis being utilized to form a sort of sphincter, such as is sought for in some of the operations of gastrostomy or jejunostomy. The resistance afforded by the costal arch and the portion of the rectus strengthened by the lineæ transversæ offers a better support for the retentive apparatus; gravity is not an important element in the occurrence of prolapse; there is no prominent anterior superior spine to make the application of retentive apparatus difficult; the fæces, although sufficiently consistent, are not so offensive as at the sigmoid flexure, and the opening, if established for temporary purposes, is more easy to close (McGavin, *Clin. Soc. Trans.*, 1906, vol. xxxix, p. 69).

The above merits of the transverse operation are fairly stated, except as to the implied suggestion that it is a preferable operation to inguinal colostomy for general use. Against this view it must be urged that, although it affects the nutrition of the body to a very small extent, yet the exclusion of a greater length of the intestinal canal than is actually necessary is inadvisable. It is also obvious that the anatomical arrangement of the mesocolon, especially beyond the mid-line, are such as to allow of prolapse more readily than in any other segment of the large intestine, and in fact this accident is more frequent and pronounced than in properly performed iliac colostomies.

Operation. The incision should be vertical, its centre above the level of the umbilicus, and carried through the separated fibres of the rectus muscle.

The further details of the operation do not differ from those described in the case of iliac colostomy, except in so far as it may be necessary to free the attachment of the great omentum, both as a matter of convenience in fixing the bowel, and to minimize the size of the opening in the abdominal wall.

ILIAC COLOSTOMY

An oblique incision 4 inches long is made, the centre of which impinges at right angles on the junction of the middle and outer thirds of a line carried from the umbilicus to the anterior superior iliac spine.

The skin and the subcutaneous tissue are divided, and the vessels

secured. The aponeurosis of the external oblique is incised in the direction of its fibres, and the fibres of the internal oblique and transversalis muscles are separated with a retractor and blunt dissector. The gap in the muscles thus obtained is stretched with a pair of retractors to the desired size, and the peritoneum is opened.

When distended, the sigmoid colon often bulges into the wound; if this be not the case and any difficulty arises, the small intestine must be

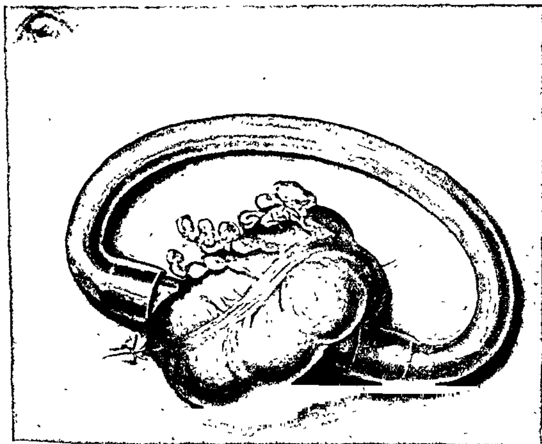


FIG. 179. THE SIGMOID FLEXURE SUPPORTED ON A GLASS ROD. A loop of rubber tubing is applied to hold the rod securely in position.

displaced inwards with plugs, and the colon sought for in the iliac fossa. The flexure is never absent except in the case of transposition of the viscera, but shortness of the mesentery may make it difficult to get the bowel into the wound.

When secured, the loop is followed upwards until its most fixed point, the junction with the descending colon, is reached. This portion is employed for the purposes of the anus, the precaution being designed to guard against the subsequent occurrence of prolapse, which is more likely to occur if a part with a long mesentery be employed (Cripps).

The loop is drawn forward, and with a blunt instrument a gap is

made in the mesentery between the vessels, through which a glass rod (see Fig. 179) is introduced to lie on the abdominal wall transversely to the long axis of the wound. A single stitch should be passed at either end of the loop, including the margins of the skin wound and the anterior longitudinal muscular band of the bowel. These stitches serve to support the loop, if necessary, when the glass rod has been removed.

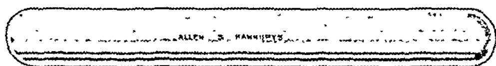


FIG. 180. GLASS ROD FOR COLOSTOMY. Full size.

Other methods of fixation may be employed in place of the rod, such as Burghard's pins (see Fig. 181), or a folded plug of gauze may be passed through the opening in the mesentery. If it be preferred, the use of any such appliances may be replaced by the passage of a single mattress stitch across the centre of the wound, including the two skin margins and the intervening mesentery, so as to establish a cutaneous bridge in the concavity of the exposed loop of bowel (Ward).

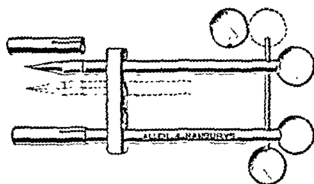


FIG. 181. BURGHARD'S COLOSTOMY PINS. Half-size.

The appendices epiploicæ may be ligatured at their base and removed. If the colon requires to be opened at once, the angles of the abdominal wound are sutured, and a gauze plug is carefully wound around the base of the projecting loop. A purse-string suture is made to surround a sufficiently extensive area, and in the centre of this the bowel is incised, an assistant seizing either edge of the opening as it is made. A Paul's tube is then rapidly inserted into the opening and the purse-string suture drawn up and tied. A second thick ligature of silk should then be tied around the portion of bowel surrounding the tube to reinforce the weaker purse-string thread. The Paul's tube is provided with a soft rubber tube to convey the contents of the bowel into a suitable receptacle. The tube separates spontaneously on the third or fourth day. The support to the loop of bowel is better left until the fifth or sixth day, when it may be removed.

When immediate relief is not required, the exposed loop of bowel is left for three days, and then opened. The safest method of procedure is

to remove as large an oval portion of the wall as possible. This method is preferable to complete division of the bowel on the rod. No anæsthetic is necessary, and bleeding is readily controlled.

The future control of the anus is effected by means of some sort of pad. The most generally useful apparatus consists in a cup with a pneumatic rim, which is fitted over the opening, and retained by a belt. The older fashioned plug is unsatisfactory, and indeed, when the artificial anus is of old standing, a simple pad of lint is comfortable and efficient. When the colotomy is upon the right side and the fæces fluid, a receptacle should be added to the cup. In the case of a left inguinal colostomy, if care be taken with the diet, it is usually possible to get the bowels to act at fairly regular intervals; thus on rising in the morning, again after breakfast, and later not more than once during the day. Too much care cannot be taken in the fitting and adjustment of the colostomy pad, since on its efficient action the comfort of the patient and the reputation of the operation will depend. In the after-treatment washing out of the distal portion of the bowel should be done at regular intervals, especially if an ulcerating growth is present. This is best done from above downwards. The advantages gained by the possibility of this procedure are sufficiently great to render undesirable the method in which the colon is completely divided, and the lower end of the bowel sutured and allowed to drop back into the abdomen.

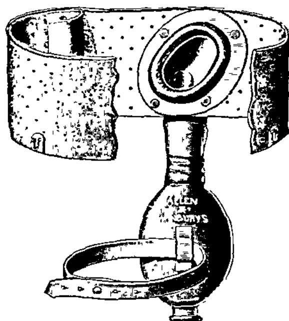


Fig. 182. Colostomy Cup and Belt with Receptacle attached.

The desirability of providing a substitute for the normal anal sphincters has led to numerous attempts to provide some muscular control of the artificial anus. When the fact is considered that no substitute for the tonic contraction of the internal sphincter can be found, it is evident that no more can be hoped for than is gained by the separation of the muscular fibres of the abdominal wall rather than incising them across their course.

Difficulties. In spite of the general ease with which iliac colostomy can be performed, yet certain difficulties and complications arise with sufficient frequency to need notice.

The most common technical difficulty experienced is dependent on the nature and condition of the mesosigmoid. The length of this fold may be deficient, as a result simply of individual conformation; more often the shortening is due to morbid conditions. Thus mesenteritis may have been the result of simple inflammatory change, or some form of specific infiltration, especially when ulceration has been in progress; or the shortening and rigidity of the mesentery may be due to the implication of the lymphatic vessels and glands, especially in cases of malignant disease. Again, adhesions may have formed, fixing the colon to other portions of the gut; thus the writer has had to deal with adhesion between the sigmoid colon and the stomach by removing a part of the stomach-wall. If there be adhesions between a growth of the pelvic colon and

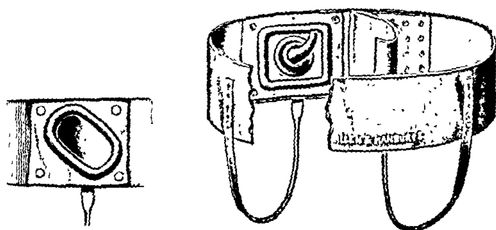


FIG. 183. COLOSTOMY CUP AND BELT.

coils of the small intestine, the complication is liable to render the performance of a colostomy of very transient benefit, as secondary obstruction may soon develop. Great distension or great contraction of the bowel may also give rise to considerable technical difficulty.

Shortness of the mesentery has to be met in a variety of manners; thus the parietal peritoneum may be incised at its junction with the mesentery and the latter stretched. If this course be taken, care must be exercised to avoid too great tension on the vessels, and consequent interference with the vitality of the extruded loop. In some cases the difficulty may be got over by separation of the growth itself when the latter is in the immediate neighbourhood of the wound. The growth is then drawn outside the abdomen, the bowel fixed, a Paul's tube inserted well on the proximal side, and the growth is removed a day or two later. When dealt with in this manner the growth necroses unless soon taken away.

When operating for urgent obstruction, the colon may be sutured to

the parietal peritoneum, and opened in the depth of the wound. Although this is sometimes expedient, it is a most unsatisfactory procedure, the artificial anus under such conditions seldom continuing to function more than a week or two, after which time the performance of a second operation has to be undertaken.

The proper procedure under the circumstanes is to secure the transverse colon in place of the sigmoid. It is frequently possible to draw the transverse colon into the iliac colostomy wound, since the previous distension has often resulted in increase in its length, and a correspondingly low position in the abdomen. If this be not possible, a second incision should be made in the abdominal wall, and a proper complete transverse colostomy performed.

Complications. *Peritoneal infection* may be said to be a rare event, even when the colon is at once opened. This happy circumstance is in some degree due to the fact that the subjects of the operation have been suffering from a varying degree of auto-intoxication for a long period before the operation, and thus have acquired a certain immunity and protection. In this particular, the advisability of exercising especial care when ascitic fluid is present should receive mention. Such fluid is difficult to retain if present in material quantity, and its leakage not only favours infection, but also interferes with the proper healing of the wound. It is best, therefore, to remove as much fluid as possible at the time of the operation, and prior to the opening of the bowel.

Cellulitis of the abdominal wall occasionally occurs as a result of imperfect adhesion of the bowel to the abdominal wound. It usually gives rise to troublesome symptoms, amongst which may be mentioned distressing hiccough. A large area of the abdominal wall may be involved which needs to be treated with numerous incisions. Cellulitis is not uncommonly a consequence of secondary interference with the wound; thus in the removal of stitches, or of the means employed for holding up the loop. It should be mentioned that cellulitis is very apt to occur if a Paul's tube be tied in on the second day, in cases where the termination of a two-stage operation has to be decided upon more hastily than was intended. The necessary tension exerted in tying the bowel to the tube loosens its adhesion, and opens the way for infection of the wound in the abdominal parietes.

Failure of the bowel to form proper adhesions and falling back of the loop into the abdominal cavity occasionally occur. Speaking generally, this accident may be said to be most often the result of imperfect fixation at the time of operation, but cases, especially of advanced malignant disease, do occur where not only is the immediate effusion of plastic lymph insufficient, but where the lymph at first effused either fails to develop into proper adhesions, or becomes again absorbed. Failure to obtain

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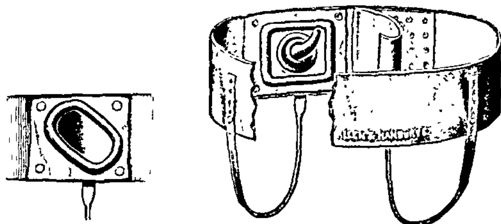


FIG. 183. COLOSTOMY CUP AND BELT.

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Later troubles of colostomy lie in *retraction of the spur*, allowing the passage of fæces by the normal route to be resumed; in *contraction* of the artificial anus; in *prolapse* of the mucous membrane or of the bowel itself; and in *extension of the growth* to the mouth of and obstructing the anus.

Retraction of the spur is best guarded against by the formation of a prominent one at the time of the operation, but is sometimes impossible to prevent, particularly in patients with a thick abdominal wall. It is an accident of some importance, since it not only partially destroys the object of the operation by allowing fæces to pass beyond the opening, but it also favours the contraction and spontaneous closure of the anus. Contraction of the opening may be treated by the introduction of tents, followed by the methodical use of a bougie, which often suffice in the earlier periods to sufficiently restore patency. Later it may be necessary to incise the structures of the abdominal wall above and below the artificial anus.

Prolapse—protrusion of the mucous membrane or of the bowel—may prove a serious complication, causing much discomfort to the patient, since it often renders the retentive apparatus inefficient. Again, strangulation of the prolapse occasionally occurs. The prolapse may vary in character; it may affect equally both the proximal and distal limb, the proximal only, or more rarely the distal segment alone. In the slighter cases the condition may be found to vary with the tonicity of the bowel and the consistency of the motions. In more severe cases the redundant mucous membrane may need to be carefully trimmed away with scissors. When an entire prolapse exists it may be several inches in length, and under these circumstances it is best (after having reduced the prolapse and sewn up the opening as in the procedure for the closure of an artificial anus) to carefully free the bowel, draw a sufficient quantity out of the abdomen, and, after resuturing the bowel to the margins of the wound, to cut off the redundant portion, and to tie a Paul's tube into each segment.

It is not always easy to explain the occurrence of the prolapse, which no doubt depends often on individual peculiarity. In a case in which a colostomy was done in a young girl for a constriction of the rectum secondary to tuberculous disease, the operation of removing prolapsed bowel has had to be repeated twice in the course of four years, as much as 2 feet of bowel requiring to be removed. The claim made in favour of the lumbar operation, that prolapse does not occur, is incorrect, as considerable prolapse from a lumbar anus has been not rarely observed.

Extension of the growth to the mouth of the anus is rare when the latter has been made at a sufficient distance above the obstruction. It

sufficiently strong adhesions is also sometimes seen when colostomy is performed in young infants, as for imperforate anus. Escape of the bowel from its new connexions, and even the prolapse of small intestines during expulsive efforts, or during fits of screaming, has in fact occurred sufficiently often to form a definite objection to the performance of inguinal colostomy in the very young. It may be mentioned that even in adults expulsive efforts have been known to cause bursting of the wall of the sigmoid colon itself, with consecutive prolapse of the small intestine. Such a case has been put on record by Barnsley, in which, after replacement of the bowel and repair of the rent, the patient recovered.

Hæmorrhage from a colostomy opening is a rare event except in cases of ulcerative colitis; in this disease it may be alarming, and the writer has also seen hæmorrhage cause death in a patient operated upon for advanced tuberculous ulceration with anal obstruction.

A very embarrassing complication may arise in the occasional *failure of an artificial anus to act*. When it is remembered that in the majority of cases of acute obstruction the immediate cause is a complete loss of tone and contractility of the colic muscle, it is not surprising that this condition should be met with. In some instances the failure of the anus to become functional may be due to the presence of a second source of obstruction, and this question when it arises is one of great anxiety to the surgeon, since such an obstruction, if existent, requires secondary measures, such as an anastomosis, the freeing of adhesions, or a second colostomy, for its relief. The need for such secondary operation is, however, rare, and as a rule sufficiently active purgation will remove the difficulty. The fact that in such cases distension of the cæcum is usually a marked feature often suggests a secondary growth in the neighbourhood of the hepatic flexure. This is, however, seldom the case. An instance of this kind, of an especially striking nature, may be mentioned. The patient, a man of 60, with little previous warning was seized with sudden obstruction, and on the third day of his attack an iliac colostomy was performed. The sigmoid loop was distended, but little beyond gas was immediately evacuated. During the next two days no further action of the bowels occurred, the abdomen was much distended, vomiting was free, and the patient was apparently not in the least relieved. A second colostomy of the ascending colon was performed on the third day, with complete relief of all the symptoms. This man was kept under observation for several months until the time of his death, when a post-mortem examination revealed no trace of obstruction beyond the primary growth of the pelvic colon. Both artificial openings remained patent until death, but the passage of fæces from the iliac anus was fitful and small in quantity, the majority escaping by the upper one.

CHAPTER IX

ENTERECTOMY AND COLECTOMY

GENERAL INDICATIONS FOR ENTERECTOMY

THE *main indications for enterectomy* may be set forth as follows, details as to the special conditions dependent on the form of disease calling for treatment being considered in the sections devoted to each:—

1. Injuries to the bowel (see Chap. VII).
2. Gangrene in internal or external herniæ.
3. Strictures of the bowel, either congenital or acquired (see Chap. XIII).
4. Fæcal fistulæ, under special conditions (see Chap. XI).
5. Embolism or thrombosis of the mesenteric vessels (see Chap. XIII).
6. Certain intussusceptions (see Chap. XIII).
7. Certain volvuli (see Chap. XIII).
8. Tuberculous disease of the bowel.
9. Certain chronic inflammatory conditions.
10. Morbid growths of the bowel.
11. Growths of neighbouring organs, involving the bowel.

As to the general application of enterectomy, it may be laid down as a rule that the measure is only to be resorted to when absolutely necessary. If a wound or a perforation can be sutured, or the obstruction due to a simple stricture can be satisfactorily overcome by a plastic operation, no doubt can exist as to the superiority of the more conservative method, although at the moment excision and axial union appear a neater and more workmanlike procedure.

Evidence, both clinical and experimental, has shown that in most cases in which a complete axial enterectomy has been employed the segment of bowel proximal to the line of union remains permanently more or less thinned and dilated. These changes have been ascribed to partial obstruction of the lumen due to the presence of an incomplete diaphragm, produced by the inversion of the bowel-wall at the point of union (Ballance and Edmunds, *Med. Chir. Trans.*, 1896, vol. lxxix, p. 300); or to the permanent effects produced by the action of toxines formed in the stagnating contents of the bowel in cases where obstruction has existed (Barker, *Lancet*, 1905, vol. i, p. 1062). A perhaps more plausible

does occasionally occur, and under these circumstances the growth may extend into the skin of the abdominal wall, forming more or less warty masses, often retaining an unbroken surface for some time.

Prognosis and results. The operation of colostomy in itself is unattended with any considerable risk to life; thus a preliminary colostomy made with the object of subsequent further procedure seldom gives rise to anxiety or is followed by a bad result. The nature of the indications for the operation—inoperable carcinoma, the last stages of intestinal obstruction, &c.—naturally prepares us for a considerable post-operative mortality. Of sixty-seven cases of simple colostomy for malignant disease performed at St. Thomas's Hospital between the years 1891 and 1907, no less than thirty-four, or 50·7 %, died. In Hartmann's practice (*Chir. de l'intestin.*, 1907, p. 386), of sixty-three patients subjected to the operation for relief of the consequences of malignant disease, fourteen, or 22·2 %, died.

Tuberculous disease. This may become an indication for enterectomy in three forms: (1) As the hyperplastic, where definite tumours, often of large size, have to be dealt with. (2) As the entero-peritoneal form, in which peritoneal adhesions, surrounding infiltration, and possibly stenosis may one or all be present. (3) As single or multiple stenoses of the intestine, often free from adhesions or surrounding disease, and possibly at the time that operative interference is undertaken offering little evidence, even histologically, of their original nature.

The symptoms demanding enterectomy are in the main those of more or less severe chronic obstruction, interference with the digestive functions, accompanied by progressive weakness and emaciation; or where the disease is active and accompanied by ulceration, those indicating chronic entero-intoxication.

Many of the earlier successful cases of operative treatment were instances in which tuberculous tumours of the hyperplastic variety had been mistaken for malignant growths, and subsequent experience has shown that the discrimination of the two diseases is far from easy clinically, and may necessitate the use of the microscope, if a certain conclusion is to be arrived at. This is happily of comparatively less moment, since extirpation is the method of treatment best suited to either condition. Mayo Robson, in recording some successful cases of intestinal tuberculosis treated by enterectomy, exclusion, or colostomy, compares the results with those obtained by laparotomy in peritoneal tuberculosis, and urges that additional advantage is gained by removing a local infecting centre (*Clin. Soc. Trans.*, 1902, vol. xxxv, p. 58).

In fact, cases of obvious tuberculous disease of the cæcum, of the subserous variety, do appear to have benefited by a simple laparotomy. Thus Hartmann quotes nineteen cases, collected by Campiche (*Deutsch. Zeitschr. f. Chir.*, 1905, vol. lxxx, p. 519), in which 15·7% cures were obtained by this measure. In cases, however, where the disease exceeds in extent the simple subserous form, little is to be hoped for from simple laparotomy, and this opinion is supported by the unsatisfactory results often following appendicectomy for tuberculous disease, if not limited to the part removed.

The conditions to be dealt with differ somewhat in the small and large intestine. In the former, localized strictures, not unfrequently multiple, and adhesions are the conditions most frequently demanding relief. In the latter, tumours of considerable size may require removal, the favourite seat of which is the ileo-cæcal region. Occasionally the disease may assume the hyperplastic form in the small intestine; thus McCosh and Thacker (*Med. and Surg. Rep. of the Presbyterian Hospital,*

explanation may be, that the complete division of the intermuscular nervous plexus produces a dead point or stop in the wave of peristalsis, with the result that local distension occurs, while a greater strain is thrown on the distal segment of the bowel in the propulsion of the contents forwards. Again, disturbance of the normal trophic influences following section of the plexuses may be concerned in the changes in the intestinal wall.

Putting this objection aside, the significance of which for the well-being of the patient can hardly be determined, it is remarkable how great lengths of the small intestine may be resected without producing any serious signs of interference with the general nutrition of the patient. This observation goes to show that the intestinal tract forms no exception to the rule observed elsewhere in the economy of the body, *i. e.* that the provisions for the performance of the normal functions always afford a wide working margin. It has been pointed out by Schlatter (*Centralb. f. Chir.*, 1906, vol. xxxii, p. 1354) that the length of gut removed is not the sole factor concerned, since 2 yards may be removed from some patients with small effect, while in others the removal of a few inches may be of importance. In two cases recorded by him, 1½ and 2 yards respectively were removed with no bad result beyond slight loss of strength. In these cases the loss of absorption of albumen and fats was shown to be abnormally great; while the patient from whom 1½ yards were removed needed more food than the one who lost 2 yards, as in the former the case was complicated by the presence of extensive adhesions. Care ought to be taken in dieting these patients to compensate for the loss of absorbent surface. Removal of the large intestine is naturally of less moment in this particular than is the case with the small gut (see p. 479).

Gangrenous hernia. In gangrenous hernia two classes of cases are met with: (1) Those in which the gangrene is limited to the site of the constriction, or takes the form of a more or less localized patch at the convexity of the strangulated loop corresponding with the area supplied by the terminal portion of the circulation. (2) Those in which infective cellulitis exists, either as a cause or a consequence of the strangulation, and extends for a varying distance along the proximal segment of the gut into the peritoneal cavity. In this class some difficulty may be experienced in determining at what level the section of the bowel should be made. The appearance of the gut and its power of contraction are perhaps the best guides, to which may be added the evidence of thrombosis of the mesenteric vessels gathered from their want of pulsation, possible palpability as cords, and the absence of proper bleeding on incision of the bowel.

These rules apply equally to the rare instances in which a localized hyperplastic tumour of the small intestine needs removal. The operative treatment of extensive entero-peritoneal disease is considered under the heading of Exclusion of the bowel.

In a very considerable proportion of cases tuberculous disease of the intestinal tract is limited to the ileo-cæcal region; thus, in 100 cases collected by Fenwick and Dodwell, the cæcum was affected in eighty-five, and in 9·6% of these it was the only part affected. Ileo-cæcal tuberculosis offers one of the varieties most suitable to surgical treatment, and

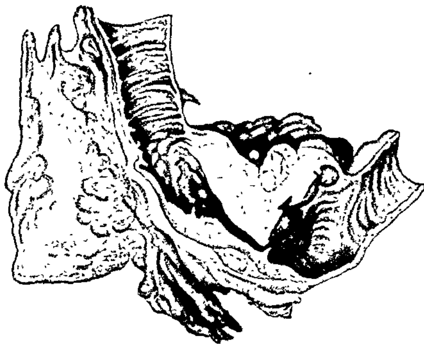


Fig. 185. HYPERPLASTIC ILEO-CÆCAL TUBERCULOSIS. (*Hartmann.*)

the subject has been admirably handled in an address given to the Medical Society of London by Hartmann (*Med. Soc. Trans.*, 1907, vol. xxx, p. 334).

Certain chronic inflammatory conditions. This indication is founded upon a number of observations made in cases treated by enterectomy, under the false impression that the surgeon was dealing with malignant disease of the bowel. A small proportion of them are possibly tuberculous in origin, but the large majority probably belong to the category to which practical surgical attention has been particularly drawn by American surgeons, under the somewhat unfortunate designation of diverticulitis. The association of false diverticula of the intestine with obstruction of its lumen has long been recognized, and a certain number of instances have found their way into modern statistics of the causes of intestinal obstruction, while the condition was described, as early as 1858, by Sydney Jones in the *Transactions of the Pathological Society of*

New York, January, 1902) record the removal of a spindle-shaped tumour of the ileum, 4–5 inches long and 2½ inches in diameter, with several lymphatic glands enlarged to the size of a pigeon's egg in the mesentery, which was probably of this nature.

When the small intestine is the seat of the disease, the most frequent indication for enterectomy is stenosis. Excellent rules for the procedure, in cases either uncomplicated or accompanied by the presence of moderate adhesions and glandular implication, have been laid down by Caird (*Scottish Med. and Surg. Journ.*, 1904, vol. xiv, p. 22):

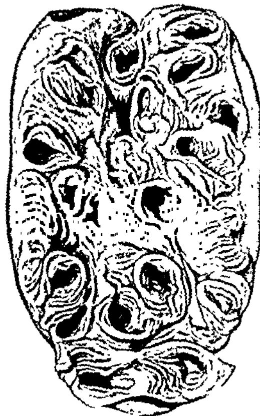


FIG. 184. ENTERO-PERITONEAL DISEASE OF THE SMALL INTESTINE. The coils are connected by a mass of dense connective tissue. (*St. Thomas's Hospital Museum*, No. 1144.)

1. 'If the stricture be non-adherent, be localized and solitary, divide well above the proximal dilated portion, since there is a tendency for the development of secondary tubercles and points of erosion and ulceration above the primary lesion. Always search for other strictures. Should there be multiple strictures separated by a lengthy interval of healthy intestine without glandular implication, it is better to deal with each stricture individually, than to excise an undue length of the alimentary canal.'

2. 'In dealing with an area of coils matted to each other, first ascertain the extent and relation of the parts involved, then identify the free proximal and distal intestine; apply clamps, and proceed to remove the entire mass. The mesentery may be divided close to its origin, as this entails the division of fewer, if larger, vessels, and allows the removal of all the infected lymphatic glands. The latter cannot well be dissected out without damage to the blood-supply of the intestine, hence it may be necessary to remove much bowel in the process of clearing them away. Should the mass be at any point adherent to an adjacent healthy loop, it would appear necessary to excise the implicated wall of that loop, and so avoid the possibility of leaving a future focus of the disease.'

Malignant disease. The indications for operation in cases of malignant tumour of the bowel are signs of obstruction combined with certain local conditions.

Sarcomatous tumours are of comparatively rare occurrence, forming not more than 2% of all malignant tumours of the bowel. They are met with much more frequently in the small than the large intestine, and are usually only discovered in an advanced stage of growth, since they give rise to little or no narrowing of the lumen of the bowel.

A type axial enterectomy in one stage is the most suitable method of removal in the small intestine. The main difficulty in this procedure may lie in the extirpation of the mesenteric glands, which when involved may far exceed in size the primary growth and necessitate for their removal the resection of an area of mesentery which compromises the vitality of the bowel for a much greater extent than that occupied by the tumour. The occasional existence of multiple tumours must also be borne in mind. In the great majority of instances the growths themselves are free and movable.

Carcinomatous tumours are more common, and of these 95% are situated in some portion of the large intestine. They present themselves in two forms as affecting practical surgery. (1) As a growth of considerable bulk, increasing rapidly in size, accompanied by superficial ulceration towards the lumen of the bowel, and often by considerable surrounding inflammatory infiltration, resulting in the formation of external adhesions both peritoneal and retroperitoneal. Such growths may obstruct the lumen of the bowel but little. (2) As localized annular infiltrations, involving a very limited length of the bowel-wall, unaccompanied by much ulceration, but causing extreme stenosis. A growth of this nature, when viewed from without, may be so limited as to suggest that a ligature with a piece of whipcord has been applied.

In some 40% of all cases a tumour may make the diagnosis comparatively easy; in others the growth may be completely impalpable. When palpable, its presence may only be occasionally demonstrable, and under such circumstances its position may be indicated by local peristaltic waves in the proximal portion of the gut; again, local pain or tenderness may aid in the determination of its site. In many cases the portion of gut above the tumour is thickened and distinctly palpable, but care must be taken not to mistake the cord-like thickening due to enterospasm for the hypertrophy accompanying distal obstruction.

The methods of dealing with colic growths by enterectomy vary with the attendant conditions, but they may be divided into four classes.

1. *The growth is excised, and immediate union, preferably of the lateral type, is effected.* This method constitutes the ideal, and is that which has

London, vol. x, p. 13. In recent years a number of observations have been made as a result of operations, in which the symptoms and signs produced by inflammatory conditions have simulated in an extraordinary degree those of malignant disease. Again, the mysterious disappearance of tumours deemed to be malignant and inoperable by surgeons of experience after simple exploration, and the surprising results of colostomy under somewhat similar circumstances, all tend to show that inflammatory conditions, especially in the large bowel, giving rise to obstruction and its complications, are far from uncommon (Moynihan, *Trans. Clin. Soc.*, 1907, vol. xl, p. 31).



Fig. 186. Peridiverticulitis of the Sigmoid Flexure. Thickening due to chronic inflammation, principally in the muscularis and subserosa. Numerous diverticula. (*Mayo.*)

A certain small proportion of cases of this nature demand an enterectomy. When the inflammatory condition leads to local suppuration, a simple incision may suffice to relieve the patient, but in some instances, where the abscess empties itself into neighbouring viscera, more extensive procedures may need to be undertaken. In an instance reported by Brewer (*Trans. Amer. Surg. Assoc.*, 1907, vol. xxv, p. 258), a perforating ulcer was discovered by abdominal section, and unsuccessfully treated by suture When inflammatory tumours lead to the development of acute obstruction, a temporary colostomy may relieve the symptoms and even cure; more commonly the colostomy needs to be followed by a secondary enterectomy. Lastly, where a chronic tumour, accompanied by signs of obstruction, persists, a primary one-stage enterectomy is indicated In five cases operated upon by W. J. Mayo (*Trans. Amer Surg. Assoc*, 1907, vol. xxv, p. 237), the disease was found to be limited to from 4 to 8 inches of the gut.

preventing distension in cases where the atonic condition of the intestinal muscle is not satisfactorily recovered from. Again, the vent may prove a useful safeguard when the local conditions are such that eventual contraction at the point of union of the bowel may have to be reckoned with later.

4. *Preliminary mobilization and eventration of the growth, combined with colostomy, followed by secondary removal of the tumour, and eventual closure of the artificial anus by an instrument on the principle of the enterotome of Dupuytren.* This method has the disadvantages of requiring a very prolonged period and repeated operations for its completion, but in the hands of von Mikulicz, its chief supporter, it has furnished excellent results both immediate and remote. This is the more striking, in that the possibility of complete extirpation of the lymphatic glands and vessels is less likely than in a one-stage primary enterectomy.

TECHNIQUE OF ENTERECTOMY

Reunion of the intestine after the excision of a portion may be effected by one of three methods :

1. Axial, or end-to-end union.
2. Lateral anastomosis, with closure of the cut ends.
3. Lateral implantation, or end-to-side union.

ENTERECTOMY WITH AXIAL UNION

End-to-end union supplies an ideal result from a cosmetic point of view; one joint only requires to be made, and thus a minimum expenditure of time is ensured, while risk of leakage is limited to a single source.

Certain practical dangers, however, attend the method; thus the necessity of including the 'mesenteric angle' in the line of union in operations involving the small intestine, or the much wider uncovered posterior aspect of the bowel in some parts of the colon. Again, the line of incision crosses the course of the larger branches given off by the vasa recta to the bowel itself, thus tending to endanger the nutrition of the cut margin more than is the case with incisions involving the antemesenteric aspect of the bowel. Further, the main blood-supply to the margins is to some extent compromised by the necessary incision of the mesentery. Likelihood of the formation of a diaphragm as a result of inversion of the united margins may be fairly claimed to have been eliminated by modern methods of suture, although this was a fertile source of trouble in the early history of enterectomy, sometimes giving rise to more or less serious obstruction.

A consideration of the statistics relating to the general results of

been followed by the best results. It is unfortunately restricted in its application, since for its safe performance the general condition of the patient must be good, and no distension of the intestine must be present.

2. *A preliminary anastomosis is effected, to be followed by secondary excision of the growth.* This method, like the first, is only to be undertaken under satisfactory conditions, such as the absence of any considerable chronic distension, or anything approaching acute obstruction. It is founded upon the same principle as a gastro-enterostomy undertaken as a preliminary to the performance of a partial gastrectomy, in cases in which the general condition of the patient is bad, and where temporary relief to the obstruction may be expected to effect improvement both in the general and local conditions. This method possesses the very great advantage over the next of allowing the secondary enterectomy to be performed under normal conditions as far as the risks of operative infection are concerned.

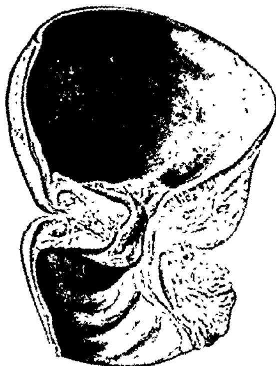


Fig. 187. Annular Malignant Stricture of the Sigmoid Flexure.

3. *Preliminary colostomy, followed by secondary enterectomy and eventual closure of the artificial anus.* This method is that most generally suited for adoption in cases where severe chronic or acute obstruction exists. The establishment of the artificial anus removes immediate risks, allows time for the distension of the bowel to subside, for recovery from atony of the intestinal muscle, and obviates the increased risk dependent on the exceptionally septic state of the contents of the intestine when obstruction has been marked. It has the disadvantages of the discomfort which accrues from the presence of the artificial anus, and the more serious one of prejudicing the chances of the secondary enterectomy by affording an additional source of infection at the time of operation. The desirability of eventual closure of the artificial anus is also a disadvantage, since this step necessitates a considerable prolongation of the time needed for the completion of the treatment. The artificial anus may, however, prove a valuable adjunct, serving as a vent-hole, and

incision to absorb any leakage, and protect the deeper guards. Each end, as divided, is cleansed by wiping with a dry sponge, and if desired may be treated with an antiseptic—preferably alcohol or solution of biniodide of mercury—prior to wrapping it up in a piece of gauze. Section of the bowel is most simply effected by the use of the knife or scissors. Since, however, this step forms one of the crucial moments in the operation, many devices to lessen the risk of diffusing infection have been employed. Thus a crushing clamp is often applied at the point to be divided, or the section is made with the thermo-cautery.

The ends having been temporarily safely disposed of, the mesentery is divided to the required extent, and removed. There is some practical advantage in commencing the procedure at the proximal point, as by this means the larger vessels are first met with, and the amount of hæmorrhage is minimized. It must be borne in mind that the free escape of blood into the field of operation much increases the risks of diffusing infective matter. The amount of mesentery to be removed varies much, according to the indication for the enterectomy. When the mesentery is healthy, as in cases of wound, and where a small piece of gut only needs removal, the mesentery may be freed from the attached margin, the vessels secured, and the mesentery plicated with sutures (see Fig. 188). In cases where extensive gangrene with thrombosis of the vessels exists or in cases of malignant or tuberculous disease, where it is necessary to extirpate lymphatic glands and vessels, a wedge-shaped area of some size may need removal; in the performance of this step the greatest care must be exercised in dealing with the apex, lest large trunks be unnecessarily wounded, and the blood-supply to the ends of the bowel about to be united seriously endangered.

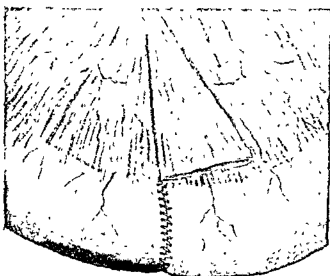


FIG. 188. PLICATION OF THE MESENTERY. The margin of the mesentery has not yet been sutured.

If the section of the mesentery be made prior to that of the intestine, the amount of hæmorrhage is reduced to a minimum; but this is not always convenient, and hæmorrhage from the cut ends of the bowel may always

enterectomy clearly shows that these dangers have exerted an important influence on the success of the operation in the past, and indicate that great care should be exercised in the selection of cases for the axial method, since the numbers undoubtedly prove a greater general mortality to attend it than has been observed after either lateral union or lateral implantation.

The question whether cosmetic reasons, and economy in time of performance, can wholly compensate for the somewhat increased risks of the axial method scarcely allows of an absolute expression of opinion, but is one of those likely always to remain open to argument according to the predilections and special capability of the surgeon. It must be conceded, however, that axial union is to be regarded as the normal procedure in most cases where the small intestine has to be dealt with, and in many where an operation on the colon is within the limits of the transverse or sigmoid segments.

Operation. The preliminary steps for the exposure and exploration of the portion of the bowel to be removed having been taken, the field of operation is protected by the insertion of gauze plugs. An outer series is first introduced, both to help in the retention of the remaining abdominal contents, and to preserve them from contamination. These will not be removed before the termination of the operation, and should be so arranged that their outer extremities thoroughly protect the tissues of the wound in the abdominal wall. A less bulky series, which can be changed if soiled during the progress of the operation, is then arranged within the protected area.

The portion of bowel to be dealt with, having been previously well drawn forward, is now clamped, the clamps including the corresponding portion of the mesentery. Some stress is laid by Kocher on applying the clamps with a slight obliquity to the transverse axis of the bowel, in order to ensure a slightly more extensive removal of the free margin of the bowel. This ensures a somewhat better blood-supply to the line of union, but care must be exercised not to produce an angle at the point of junction. The proximal clamp should if possible be first applied, the contents of the bowel below gently passed downwards by manipulation with the fingers, and the second clamp placed in position. The bowel is thus rendered as free as possible of contents.

Two inner smaller clamps are applied to control the included segment, enough space being left between them and the retaining clamps to allow a proper length of bowel to project for the purpose of the introduction of the suture.

The bowel is divided at either end about one inch within the retaining clamps, a small plug of gauze having been placed under the point of

long to unite with the terminal stitch of the final series to be introduced (see Fig. 194, D).

This first series of stitches having been introduced, the fixation threads may be removed, and attention is turned to the 'mesenteric angle'.

The importance of the mesenteric angle as a source of danger has led to the introduction of numerous devices for its effective closure. One of the most widely employed methods is the ingenious adaptation of a mattress suture of Lee, which pierces all four layers of the mesentery and the intestinal wall, completely obliterating the 'angle' (see Figs. 190, 197).

The needle is entered from the lumen of the bowel end lying on the operator's right, made to emerge exactly at the point of union of the

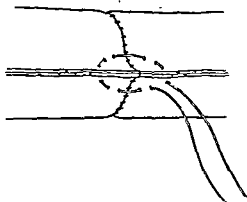


FIG. 191. MITCHELL AND HEAMNER'S MESENTERIC STITCH. (*Senn.*)

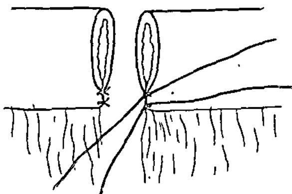


FIG. 192. SHOEMAKER'S METHOD OF TREATING THE MESENTERIC ANGLE. Two sutures have been passed through the entire thickness of the wall on either side of the mesentery.

mesentery and bowel-wall externally, and carried across the front of the gap in the mesentery to the opposite side; here it is entered at the junction of the mesentery and bowel-wall, and carried into the lumen of the bowel, whence it is made to emerge again on the posterior aspect of the gap and to enter the opposite end of the gut. The suture is knotted immediately before commencing the first half of the inner row of sutures, and if passed as above described, its knot lies within the bowel.

The mesenteric stitch lies in the same line as the inner row of sutures, and care should be taken that it does not unnecessarily include any mesenteric vessel near the cut margin.

Two other methods, illustrating the adaptation of a simple suture and a mattress suture respectively, may be mentioned. It will be noted that Shoemaker's is a preliminary measure; Lee's an intermediate step; and Mitchell and Heamner's a terminal act, in the process of union.

Mitchell and Heamner's stitch is passed at the termination of the

be controlled by temporary tightening up of the retaining clamps to a requisite degree.

The desired area of mesentery and bowel having been removed, the inner layer of plugs, if soiled, may be changed, and a special narrow plug folded in narrow layers having been introduced through the gap in the mesentery and between the ends to be united, these are approximated (see Fig. 189).

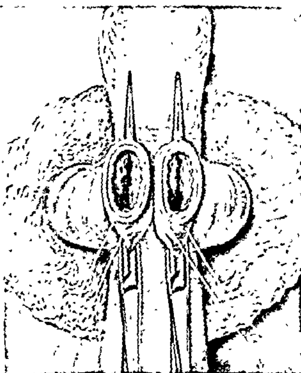


Fig. 189. Clamped Intestine in Position. The abdominal wound is protected by plugs, and a longitudinal plug is in position beneath the line of suture. Temporary fixation threads are inserted at the ante-mesenteric margin.

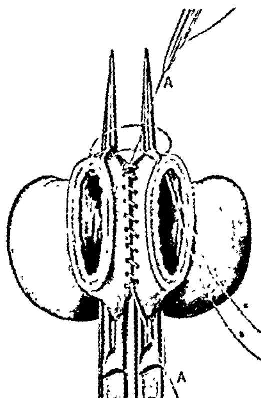


Fig. 190. Enterectomy followed by End-to-end Union. The first line of suture A has been inserted. Lee's stitch * * has been inserted at the mesenteric margin, but not tied. The fixation threads have been removed.

The handles of the clamps lying on the abdominal wall serve to roughly hold the bowel in position, but for the even introduction of the suture it is convenient to insert temporary fixation threads at the free margin of the bowel. Fixation of the mesenteric margin is obtained by utilizing the free end of the first knotted stitch, A, of the sero-muscular series. The further stitches are introduced one-tenth of an inch from the cut margin; they include serosa and muscularis, dipping into the submucosa, and are continued as far as the fixation thread at the antemesenteric aspect of the bowel. At this point the thread is knotted and left

The inner series of sutures, B, is usually made to perforate the whole thickness of the bowel, and thus serves to control all hæmorrhage. If desired, it may be confined to the mucous membrane, under which circumstances it is usually necessary to ligature a few bleeding points. The former procedure is to be generally preferred, as giving more strength of union, and as avoiding the introduction of unnecessary ligatures within the confines of the wound.

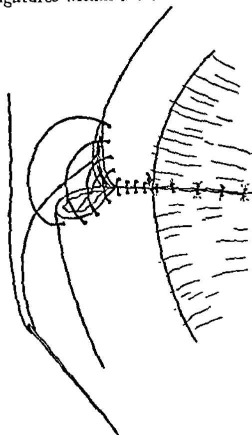


FIG. 195. METHOD OF DEALING WITH INCONGRUENCE IN SIZE.

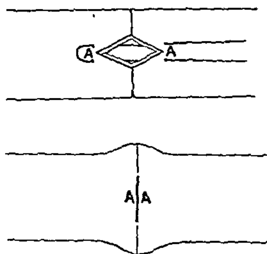


FIG. 196. METHOD OF ENLARGING THE POINT OF UNION. This is done by a longitudinal incision at the ante-mesenteric margin of both elements of the junction, followed by approximation of the ends of the incisions in the vertical line by a mattress suture. (*Cheatle.*)

The fourth line (see Fig. 194, D), the anterior series of Lembert, is now introduced, the two ends being knotted to those of A, and the union is completed

It only remains to close the mesenteric gap, if present. This requires a sufficient number of stitches to prevent any chance of leaving a hole which would be capable of giving rise to ulterior trouble as a site of strangulation. Moynihan advises that the procedure should be effected in part by tying the vessels successively on either side of the gap with the same ligature, thus minimizing the number of sutures to be introduced, and avoiding the possible inclusion of uninjured vessels by the stitches.

union (see Fig. 191). The needle is carried (1) through the mesenteric attachment, dips into the bowel-wall, (2) is thence carried across the line of union, dipping again into (3) the bowel-wall, and emerging to (4) again traverse the mesenteric attachment, thence it crosses the line of union a second time, and a complete circle is established when the ends are knotted.

Shoemaker's method (see Fig. 192) consists in passing two sutures at the mesenteric margin in such a manner as to close the entire lumen of the

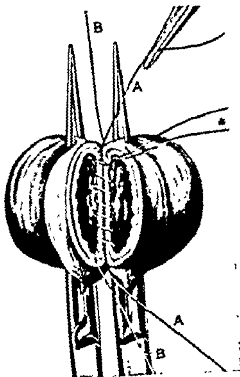


Fig. 193. Enterectomy followed by End-to-end Union. The first half of the inner line of suture B has been inserted. Lee's mesenteric stitch * has been knotted, but not cut short.

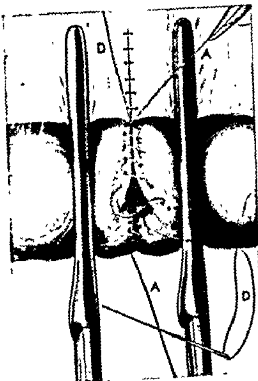


Fig. 194. Enterectomy. Anterior line of inner stitches completed. First half of final line D inserted. D has been knotted to the free end of A above, and the mesenteric gap has been closed. It only remains to complete D and knot it to the lower free thread of A.

bowel. A complete peritoneal clad ring for apposition is thus obtained, and the mesenteric angle closed. The two threads on one side may be kept long, and employed for the first and second lines of suture.

On the completion of the first line of suture, A, and the tightening of the Lee's mesenteric stitch, the first half of the inner series, B, is inserted, and knotted at the ante-mesenteric margin (see Fig. 193); thence the same line is continued over the anterior aspect, and the bowel lumen closed.

position, a Lee's stitch is introduced at the mesenteric margin, and a series of interrupted mattress sutures are used to unite the applied margins of the bowel (see Fig. 197).

This first half of the suture is passed with ease; the second needs a little practice, and a fully curved needle is required. The needle is introduced from the interior of the right element, and emerging on the peritoneal aspect is carried across the gap to enter the left element from

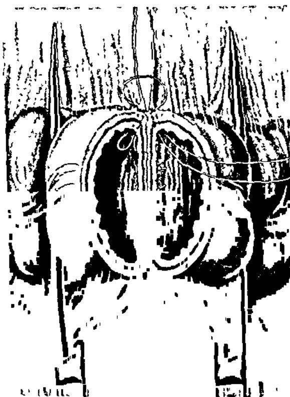


FIG. 197. UNION OF THE TRANSVERSE COLON BY CONNELL'S METHOD. The first series of interrupted sutures has been inserted and knotted. Lee's stitch has been inserted at the mesenteric margin, but not tied.

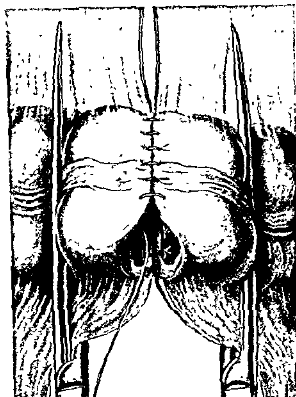


FIG. 198. ANTERIOR HALF OF CONNELL'S SUTURE. The stitches are being inserted with a continuous thread, and are not drawn tight, in order to show their direction. Note the necessary inversion of the margin shown at the lower angle of the union.

the peritoneal aspect and gain the lumen; the needle is then made to again emerge from the lumen $\frac{1}{8}$ inch further forwards and is carried across the gap to re-enter the right element $\frac{1}{8}$ inch from the point originally pierced (see Fig. 198). The two free ends now hang from the lumen of the right element and are knotted within the bowel. The necessary incurvation of the margin of the bowel may be maintained, if desired, by the application of Poirier's forceps on either side of the gap.

The sutures of the second half are readily tied until the opening is

If preferred, the union of the bowel may be readily effected by the use of two threads of sufficient length, the first stitch being knotted about the centre of the thread, and the long free end left employed for the second half of each line of suture respectively. *The two knotted points* made in each line prevent any chance of puckering of the union, and consequently of narrowing of the lumen of the bowel.

In some cases considerable *incongruence* exists in the calibre of the two ends of bowel to be united. The difficulty may sometimes be met by the removal of a sufficient portion of the narrow element, but it is seldom that this simple expedient will suffice.

Two simple methods are then at the disposal of the surgeon: (1) The length of the cut margin available for employment may be increased by incising the bowel longitudinally immediately opposite to the mesenteric attachment (see Fig. 195). (2) The narrow element may be cut obliquely (Jeannel), the obliquity being at the expense of the ante-mesenteric aspect.

Of the two methods the former is preferable.

Axial union may also be desired between portions of bowel both of which are considerably narrowed, and for such the method recommended by G. L. Cheatle and resembling that of Chaput may be employed (*Lancet*, 1897, vol. ii, p. 1113).

A similar longitudinal incision, parallel to and opposite the mesenteric attachment, is employed, but in this instance in the case of either end. The whole length of the cut margin thus gained is united transversely, and the lumen of the bowel at the point of union is actually increased (see Fig. 196).

If axial union be for any reason attempted in the continuity of such portions of the bowel as the ascending or descending colons, the problem of obtaining a complete peritoneal ring for apposition is usually insuperable. The difficulty may be lessened by certain methods, but only absolute necessity should allow such unions to be made.

The uncovered aspect of the colon may be to some extent narrowed by care in the division of the parietal peritoneum, and the formation of a small peritoneal flap from it, which flap is stitched to the cut margin of the bowel prior to the commencement of the main suture; this method is only practicable when the bowel is somewhat contracted. If the formation of a flap be impracticable, the uncovered portion of the bowel at least should be united by Connell's method, as this affords a firmer immediate union of the opposed parts; the remainder of the line of suture may be completed in the ordinary manner if desired.

Connell's method of union. A single series of completely perforating stitches is employed. The ends of the bowel having been placed in

method of inserting the final stitches may be safely avoided by the substitution of two or three deeply passed sutures of the Lembert type to close the last portion of the gap on the anterior surface of the union.

ENTERECTOMY WITH LATERAL UNION

Lateral union is applicable to almost any portion of the bowel, provided only that sufficient length and mobility exist to allow of the desired arrangement of the free ends. These latter conditions are rarely absent except in the presence of formidable adhesions, or in the case of the lower end of the pelvic colon. By the lateral method the parts to be approximated may be so arranged as to ensure the contact of plane peritoneal surfaces throughout, without the necessity of any invagination at the point of union. The incision for the purposes of communication is made in the area of the terminal twigs of the blood-supply, thus reducing interference with the nutrition of the bowel-wall to a minimum, also at a distance from the divided mesenteric trunks. The opening may be made as extensive as the surgeon may desire, while the tendency to subsequent contraction is slight. Disparity in the width of lumen of the two portions of bowel is of little importance, and calls for no special procedure. No danger is incurred of either temporary or secondary obstruction of the opening by a diaphragm, and, lastly, experience has abundantly proved the risks from leakage at the line of suture to be far less than in the case of axial unions. In fact, if the main aperture of communication alone were taken into consideration, the large proportion of competent anastomoses for gastro-enterostomy and ileo-colostomy would show that the risk from this cause is minimal. In enterectomy with lateral union, however, it must be allowed that the risk of leakage is from the blind terminal ends, which in a lesser degree offer the same conditions which constitute the danger in axial unions; still, even here, the inference cannot be avoided that an axial union might have failed where a closed end has given way. A full appreciation of this source of danger might perhaps suffice to lessen it, in so far as it is not infrequent for the surgeon unintentionally to employ rather more care and vigilance in the suturing of the actual anastomosis, than in the less exacting closure of the ends of the divided bowel.

Lateral union is the normal method of enterectomy in the large intestine, the transverse colon, the sigmoid flexure, and pelvic colon offering the only debatable exceptions.

Operation. The preliminary procedures are the same as in preparing for an axial union, with the single exception that a longer length of bowel needs to be exposed for the operation.

The required segment having been excluded by the application of

nearly closed. To allow of the knotting of the last stitches a threaded needle is introduced eye forwards from the deep aspect of the joint between two of the already knotted sutures of the first line. When the eye of the needle projects, the contained thread is drawn into a loop into which the free ends of the stitch to be knotted are inserted (see Fig. 200). The needle and loop are then withdrawn, bringing the two free ends with them out of the posterior line of suture. Traction is now exerted on the ends of the thread in such a manner as to obliterate the lumen

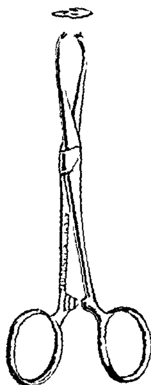


FIG. 199. POIRIER'S FORCEPS. Useful as a substitute for controlling threads.



FIG. 200. METHOD OF COMPLETING CONNELL'S SUTURE. B, Loop of thread in the eye of a needle which has been passed between two sutures of the deep line; A, Ends of the superficial stitch passed into the loop preparatory to being drawn through on the deep aspect of the joint and knotted.

of the bowel and bring the two lines of suture at this point into contact; the stitches are then firmly knotted, and cut short, and as the bowel resumes its normal tubular form the free ends are retracted into its cavity.

The method may be varied, if desired, by the employment of a continuous stitch, instead of the interrupted mattress suture (see Fig. 198); but this slightly increases the difficulty, as the thread is not readily held taut during each passage of the needle. The somewhat troublesome

suture, but if the bowel dealt with is wide, the crushed portion is so spread out by the pressure of the clamp, that the extra convenience gained is not great.

In place of the initial purse-string suture, an ordinary continuous suture involving all the coats may be used, and when the end to be closed is large this method is preferable. In either case the difficulty

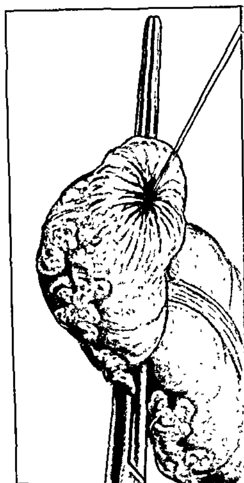


FIG. 202. PURSE-STRING SUTURE INVERTED PRIOR TO INSERTION OF THE SECOND LINE.

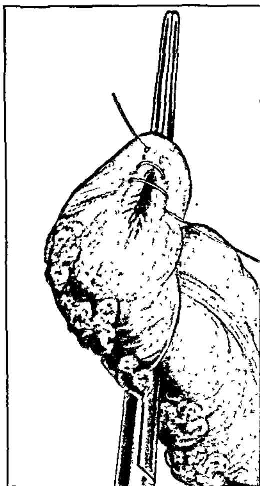


FIG. 203. INSERTION OF THE SECOND LINE OF SUTURE OVER THE INVERTED END.

dependent on the incomplete peritoneal clothing of the ascending and descending colons can be readily dealt with, as a result of the puckering induced by the purse-string suture, and if a simple line has been employed the diminution in extent can be increased by tying the end of the thread left at the commencing knotted stitch to that left at the terminal one.

The closure completed, the ends are carefully cleansed, and some

clamps, the bowel is divided, and the portion to be removed is dealt with according to circumstances. As a general rule the [illegible] cleansed, wrapped up in gauze [illegible]

[illegible] ...able con- [illegible] ...ever, particularly when there is difficulty in effecting a free extrusion of the bowel, it may be safer to sew up each end to be closed as it is divided, and proceed to the removal of the diseased or injured part later.

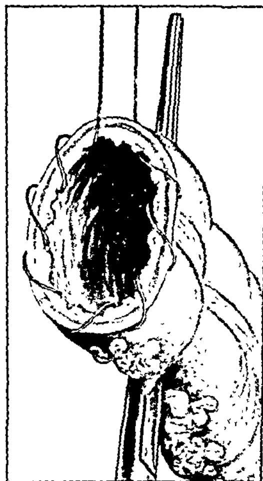


FIG. 201. PURSE-STRING SUTURE PASSED FOR CLOSURE OF THE CUT ENDS.

The removal of the diseased or injured segment in the case of the small bowel offers little difficulty in the absence of adhesions, or extensive infiltration of the mesentery. In the large bowel more difficulty may be experienced, from hæmorrhage during the process, and possibly fixation from infiltration of the retroperitoneal tissue; again, the area involved by the operation is generally appreciably wider. To meet these difficulties, the large vascular trunks should as a rule be first divided and secured, and the existence of extensive infiltration may call for careful dissection. Section of the tissues with the knife is generally preferable to forcible stripping, as the lymphatics are thus more radically removed.

Closure of the cut ends This is most rapidly effected by the introduction of a purse-string suture at the immediate margin, which perforates all the coats (see Fig. 201); this is tightened and tied. The tied end is inverted (see Fig. 202), a second continuous Lembert's suture involving the serous muscular and submucous coats is superimposed, and the closure is completed (see Fig 203). If preferred, a crushing clamp may be previously applied at the site of the projected section. This diminishes the volume of tissue to be surrounded by the purse-string

vessels. As the latter are divided it may be necessary to secure some of the larger ones by forceps, as they cannot always be efficiently compressed by the retaining clamps. All hæmorrhage being controlled,



FIG. 205. LATERAL UNION. *The bowel opened.* First half of the inner line of suture B completed. Thread ready for completion of the third line C.



FIG. 206. LATERAL UNION. *Third line of suture* C *complete.* Fourth line, D, half completed, and the terminal sutures still untied.

a puncture is made at one end of the exposed mucous membrane, and it is divided in the whole length of the desired opening, any fæcal contents being carefully caught or sponged away. The divided mucous membrane projects from the margin of the wound, and it is desirable to excise an elliptical area $\frac{1}{4}$–$\frac{1}{2}$ inch wide at the centre of the wound, as suggested

rearrangement may be necessary. The removal and rearrangement of the inner series of pads may suffice to give working room for the establishment of the anastomosis; if not, the ends must be drawn upon, and some readjustment of the retaining plugs may be necessary. Before commencing the anastomosis, it is especially important to fully protect from contamination any surface denuded of peritoneum in the floor of the wound, as such surfaces constitute one of the chief sources of danger in resections of the large intestine.



Fig. 204. Lateral Union. *First tier of the sero-muscular suture completed.* A, A, Ends left long for future knotting with the superficial tier. The two terminal sutures are inserted opposite either extremity of the line of incision.

Lateral anastomosis. The closed ends are now rendered as far as possible free of contents by gentle manipulation, and clamps are applied distally to the site of the projected anastomosis.

The further steps are identical with those of a simple anastomosis of two loops of bowel.

A continuous line of suture, 2½–3 inches in length, perforating the serous and muscular, and entering the submucous coats, is introduced, each end being knotted, and the projecting portion of the thread placed in artery forceps for union later with the corresponding ends of the final line of suture (see Fig. 204).

Two short threads are introduced in such a manner as to cross the line of the projected incision into the bowel, and are laid aside to be tied as the last step of the procedure. These stitches are intended to thoroughly protect the two extremities of the anastomotic opening.

An incision, corresponding in length to some four-fifths of the extent of the line of suture already introduced, is now carried through the serous and muscular coats, entering the submucosa and exposing the

colon was implanted into the transverse after removal of the splenic flexure for growth, the establishment of a safety-valve in the transverse colon was necessary some nine months later. This narrowing has also been observed by other surgeons, but the danger of its occurrence may no doubt be lessened by the employment of certain details to be mentioned below. The fact that Kocher, in a series of eighty-four partial gastrec-

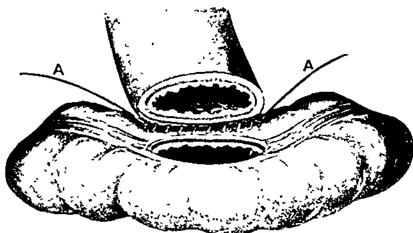


Fig. 207. Lateral Implantation. *First stage.*

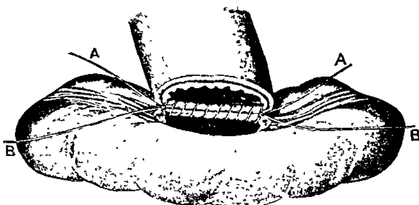


Fig. 208. Lateral Implantation. *Second stage.*

tomies, only lost a single patient from leakage at the site of the lateral implantation, speaks strongly for the immediate efficiency of this method, even if the results be discounted by the special advantage offered by the stomach as a basis of support for the union, and the technical ability of the operator concerned.

Operation. The required portion of the intestine having been removed, the cut end of the segment of bowel of larger calibre is closed by one of the methods already described, and the site of the implantation decided upon. The latter should be at least an inch and a half within

by Littlewood (*Lancet*, 1901, vol. i, p. 1817), this procedure ensuring a thoroughly patent opening, and obviating any chance of immediate or ulterior obstruction.

For the introduction of the inner line of suture it is convenient to commence by inserting the two threads intended for the deep and superficial segments respectively, knotting one at either extremity of the opening, and leaving a short free end which is secured by a pair of artery forceps. These short ends are useful to steady the bowel, while tension upon them tends to maintain parallelism of the margin of the anastomotic opening. With one long end, continuous through and through stitches are carried along the entire length of the opening, and it is tied to the short end of the second suture thread. A similar line of stitches is carried in the reverse direction through the remaining free margins of the opening with the long end of the second thread; this is knotted with the short end of the first, and the lumen of the bowel is closed (see Fig. 205).

The remaining line of continuous sero-muscular suture is introduced, the free ends being knotted to those of the first, the two short stitches crossing the line of the anastomosis at either end are tied, and the union is completed (see Fig. 206).

The exposed bowel is now carefully wiped over, and if necessary washed with saline solution, and the protecting plugs at the bottom of the wound removed to allow of the repair of the peritoneal defect in the posterior abdominal wall. This latter step is an important one, as the retroperitoneal tissue is liable to exude serum, and infection extends in it with great rapidity. If any extensive area has to be left uncovered, it is advisable to make a puncture in the loin, and introduce a drain prior to closing the abdomen. When a lateral union is made in the small intestine the suture of the mesentery is a comparatively simple matter, as the two segments overlap, but care must be exercised to avoid injury to the blood-vessels in the introduction of the few sutures required.

ENTERECTOMY WITH LATERAL IMPLANTATION—END-TO-SIDE UNION

This method possesses many of the advantages of lateral union, and an individual one, in the reduction of the risk of giving of the blind end to one source instead of two. It has found its chief application in partial gastrectomy by Kocher's method, in ileo-colostomy, and colo-colostomy. The method is most suited to ileo-colostomy. In union of two portions of the colon it has, in the experience of the writer, proved somewhat liable to contract; thus in two instances where the descending

coats, any bleeding points being controlled provisionally by artery forceps. The mucous membrane is incised, and a strip on each side with advantage removed.

A series of through and through continuous stitches is now inserted, closing first the deep, and then the superficial halves of the opening (see Fig. 208).

Finally, the anterior half of the external Lembert's line of suture is completed, the free ends of the threads being knotted to those of the posterior segment which have been used as supports during the later stages of the suture (see Fig. 209).

As already mentioned, the weak point in the method of lateral implantation is the tendency of the opening to contract. As a general rule this is to be combated by the excision of a certain amount of the mucous membrane of the receiving segment at the time of operation. This does not, however, suffice to meet all cases, and when the segment to be implanted is too narrow, the most simple procedure is to make a longitudinal incision at its ante-mesenteric aspect; by this means an opening of at least 2 inches in length is readily procured (see Fig. 210).

Omental flaps and grafts. When there is reason to suspect weakness in the union after a resection, or the inefficient closure of a perforation of the intestine, the omentum may occasionally be employed as a graft or flap sutured over the doubtful spot. Again, the omentum as a whole may be sometimes so affixed to the margins of the abdominal wound as to localize a weak spot, and protect the general peritoneal cavity in case of leakage. With regard to these methods, it may be pointed out that the use of the *omental flap* is only satisfactory in the upper segment of the abdomen, where the risk of leaving a bridge beneath which strangulation can occur may be avoided. Thus the omentum is often useful in gastric or duodenal perforations. In resections of the small intestine, an omental graft is not advisable, and is rarely necessary if sufficient intestine be removed. In resections of the colon, the appendices epiploicæ may often be used, or in the case of the transverse colon the great omentum, since their employment is not accompanied by the risk of giving rise to the development of objectionable adhesions.

Small *omental grafts* may be cut free, and sutured over the required spot. This method again is open to the objection of encouraging the development of adhesions, since the separated graft adheres equally readily to the neighbouring coil of bowel as to that to which it is sutured. As a general rule, therefore, the use of either flaps or grafts is to be deprecated, except in cases the gravity of which renders the development of subsequent adhesions a matter of negligible moment.

the closed end, and a longer distance may often be chosen, especially if any doubt exists as to the condition of the intestine at the point of section.

The protecting plugs are arranged beneath the point of union, and the clamped end to be implanted is brought to the side of the part of intestine destined to receive it.

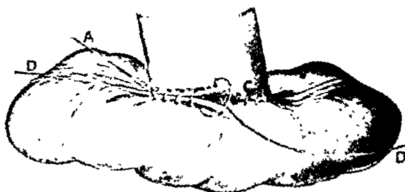


FIG. 209. LATERAL IMPLANTATION. *Third and fourth stages.*

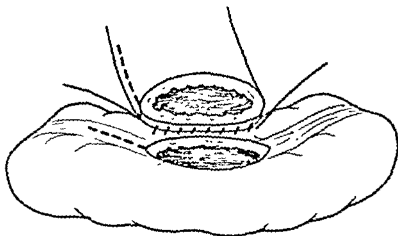


FIG. 210. LATERAL IMPLANTATION. *Method of enlarging a narrow element by incision of the ante-mesenteric margin.* The dotted lines indicate the site of the additional incisions.

The first row of external sutures is inserted in exactly the same manner as in an axial union, and should extend to half the circumference of the portion of bowel to be implanted (see Fig. 207).

When this is completed, the ends of the thread which have been kept long are taken in pairs of artery forceps, for later use as supports, and for knotting with the anterior series at the completion of the union.

An incision of the required length is made in the closed bowel, most conveniently by prior division of the serous muscular and submucous

'A needle-holder is neither necessary nor desirable, since its employment means loss of time.

'After the bowel to be operated upon has been clamped above and below, or if possible isolated by encircling the whole loop with an elastic tourniquet, the affected portion is excised, leaving the open ends to be dealt with. For convenience it is better to apply the serous suture around the distal half first, and to lay aside the threaded needle until the mucous edges have been approximated and the bone bobbin inserted, when the serous circle can be completed.



FIG. 211. ROBSON'S BOBBIN.

'The bobbin is not inserted until the marginal suture has been carried around the distal half of the circumference.

'After the insertion of the bobbin, the marginal stitch is continued around the circle, until the loose end of the catgut stitch at the starting-point is reached; the two ends are then drawn on, tied, and cut short.

'The serous suture is now continued around the circle, and when it reaches the starting-point the loose end of the silk stitch is picked up and both are drawn on, tied, and cut off. Both stitches are now buried, and a line only is seen where the union has been effected.

'If on account of want of time one suture only be employed, the marginal stitch, taking up the serous muscular and submucous coats, and avoiding as far as possible the mucous membrane, should be employed.

'The mucous margins will then be approximated though not perforated, and the buried stitch will run little danger of becoming infected.'

Murphy's button. The buttons are at present made in two forms, a circular for end-to-end and end-to-side unions, and an oblong for lateral anastomoses. The buttons are made in two halves, the male half being provided with a spring flange which exercises pressure on the ends of the included gut, while two spiral springs, projecting through openings in the hollow stem, act as the thread of a screw when the male half of the button is telescoped within the female segment (see Figs. 212, 213).

Murphy lays down the following instructions for the use of the button: 'Neither the button, its modifications, nor suture should ever be used in end-to-end anastomosis of the large intestine (except in the rectum and sigmoid), where an end-to-side or a side-to-side anastomosis is possible, as anatomically too large an area of the bowel circumference is uncovered by peritoneum' (Kelly and Noble, *Gynæcology and Abdominal Surgery*, 1908, vol. ii, p. 434).

ARTIFICIAL AIDS TO ENTERECTOMY

Although the general trend of surgical opinion is strongly towards the view that simple suture is the more desirable method for employment in enterectomy, yet in some positions undoubted convenience is to be obtained by the use of certain mechanical devices, while some operators still employ them habitually by preference.

Two principles are involved in the numerous aids which are at the surgeon's disposal:

1. *The simple provision of a temporary support* to facilitate the ready introduction of the sutures. This is illustrated by the collapsible rubber bag used by Treves and others, while the various bobbins, such as Mayo Robson's, Allingham's, and Stanmore Bishop's, are absorbable, do not need immediate removal, and provide a passage for the intestinal contents during the time they remain in position.

2. *The substitution of a mechanical device for sutures*; such device effecting both the union of the bowel, and the removal, by 'pressure necrosis', of the redundant tissue grasped by it. In these also a channel is provided for the passage of the intestinal contents during the period that the device remains in position. Such is the 'button' of Murphy, which, it may be well claimed, has exercised a more potent influence in the free application of intestinal surgery than any other individual invention.

The two methods of best proved general utility are those of the decalcified bone bobbin, and Murphy's button, and these will therefore be taken to illustrate the above principles.

Mayo Robson's bobbin. Of the various appliances devised with the object of providing an artificial support, none has proved itself more generally satisfactory than the decalcified bone bobbin. Mayo Robson, writing in 1896 (*Clin. Soc. Trans.*, 1896, vol. xxix, p. 151), after quoting certain statistics, expressed himself as follows: 'I believe artificial aids in enterectomy afford greater safety than the unaided suture,; and of the artificial aids a decalcified bone support has shown in the hands of four different surgeons the comparatively low mortality of 8·3 %.' The results obtained by Mayo Robson show the success with which the use of the bobbin has been attended in the hands of its designer; none the less he has at the present renounced its routine use in favour of methods of simple suture.

'For the application of the bobbin, two medium-sized sewing needles bent into the shape of the third of a circle are threaded, one with silk and one with catgut, the former for approximating the serous surfaces, the latter the mucous margin. If one suture only be applied, I prefer chromicized catgut.

Lateral anastomosis. For this procedure an oblong button is employed. The site of the incision is encircled with a puckering thread, but here again Murphy passes the needles, and employs them as a splint during the process of incising the bowel. The opening requires to be of a length corresponding with that of the button; the introduction of the latter is effected by introducing the lateral edge first beneath the upper margin of the opening; the button, which is held by its central stem in forceps, is then rotated beneath the lower margin of the opening, which is held up by a pair of forceps. The puckering thread is tightened, and the further details do not differ from those in an axial union.

Murphy lays great stress on the outer margin of the pressure surface of the button being an accurate semicircular curve, and not a rounded

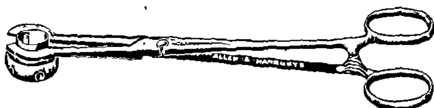


FIG. 214. HARTMANN'S CLAMP FOR HOLDING MURPHY'S BUTTONS.

off angle. He considers this of the utmost importance in the proper limitation of the extent of the 'pressure necrosis', which he says should have attained its maximum at the expiration of three days.

In spite of the success which has attended the use of the button in the hands of the inventor, and in those of many distinguished operators, its use is best restricted to positions in which methods of suture are difficult or impossible, and to cases in which a minimum of expenditure of time is obligatory. The latter indication is hard on the method, since it relegates its employment for the most part to cases of the most compromising description. The improvement in methods of suture has, however, been so great that most of the early complications and dangers have been removed from their employment, while no doubt can exist as to their greater elasticity of application, and they possess the undoubted advantage of entirely avoiding all the risks which may attend the introduction of a foreign body into the intestinal canal.

A series of entero-enterostomies comprising 750 operations for all causes has been collated from various sources by one of Murphy's assistants. In this series the remarkably low mortality of 19% is shown, or if the cases in which the operations for malignant disease are subtracted, of 14% only (*Philad. Med. Journ.*, 1900, p. 1271).

Axial union. A No. 3 button is most generally applicable.

1. The coil of bowel is freed from contents by careful compression.

2. The retaining clamps are applied to exclude the portion to be excised.

3. An aneurysm needle and thread is passed through the mesentery of the portion of bowel to be excised, $1\frac{1}{2}$ inches from the intestinal border. A ligature is tied so as to include the vessels only of that portion of the mesentery complementary to the area to be excised.

4. The mesentery is slit centrifugally from the intestine to the ligatured point.



FIG. 212. MURPHY'S CIRCULAR BUTTON FOR END-TO-END OR END-TO-SIDE UNION.

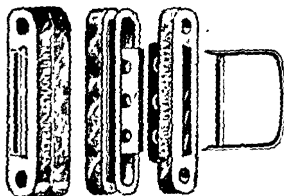


FIG. 213. MURPHY'S OBLONG BUTTON FOR LATERAL ANASTOMOSIS.

5. A thread, ten inches in length, provided with two needles $2\frac{1}{2}$ inches long, is prepared. The needles are passed as in making a pleat, one on either side of the gut from the mesenteric to the free margin of the bowel. The threads are not drawn, but the needles are maintained in position to act as splints during the division of the bowel with scissors. By this manœuvre any risk of division of the thread is avoided.

6. The gut divided, the puckering thread is drawn through by the needles, and the button, held by its central hollow stem in a pair of forceps, is placed in position in the end of the bowel. The puckering thread is then drawn tight, knotted, and cut short.

7. The process is repeated at the other end of the bowel. The two halves of the button are now taken up in Hartmann's clamps (see Fig. 214). The necessary amount of mesentery is excised, and, lastly, the two segments are approximated and firmly pressed together. No external supporting sutures are required.

Lateral implantation. The method is the same; a round button is employed, and the segment of the button inserted in the receiving element of the junction is introduced as in a lateral anastomosis.

effort to remedy this deficiency has been made by Jamieson and Dobson in a series of papers dealing with the normal lymphatic system of the colon, in which the course of the lymphatic vessels and the arrangement of the glands are accurately described, and upon the results of these anatomical investigations definite rules for the extirpation of the several lymphatic areas have been laid down. These investigations are of the greater value, since they correspond in general with the information to be gained by consideration of the numerous isolated pathological observations scattered throughout the extensive literature of the surgery of the colon, and especially with the careful pathological review of 72 cases of colic carcinomata by H. S. Clogg, appended to which are a series of suggested operations differing only slightly from those devised by Jamieson and Dobson on strictly anatomical lines (Jamieson and Dobson, 'Lymphatics of the Cæcum and Appendix,' *Lancet*, 1907, vol. i, p. 1137; Dobson, *Lancet*, 1908, vol. i, p. 149; Jamieson and Dobson, *Proc. Roy. Soc. of Med.*, 1909, vol. ii, Surg. Sect., p. 149; H. S. Clogg, 'Cancer of the Colon,' *Lancet*, 1908, vol. ii, p. 1007).

Jamieson and Dobson's observations were made on a series of specimens prepared by the method of Gerota, and may be shortly summarized as follows:—

It is pointed out that the lymphatics connected with any given segment of the colon correspond in their course and arrangement with the main arterial branches of supply to such segment. Hence the course and distribution of the latter afford an all-important general indication as to the extent of bowel, parietal peritoneum, retroperitoneal tissue, or mesentery, which requires to be removed in an attempt to completely extirpate the 'lymphatic area' which pertains to a tumour situated in any given position. Four lymphatic areas are described: (1) ileo-colic, (2) middle colic, (3) left colic, (4) inferior mesenteric. As an inconstant vessel in origin, with few glands arranged upon it, the right colic is not assigned an individual area. The lymphatic glands connected with each individual area are divided into four distinct but intercommunicating groups. (1) *Epicolic*, glands contained in the appendices epiploicæ and lying on the wall of the bowel; (2) *paracolic*, glands arranged in a line parallel to the mesenteric margin of the bowel, between the intestine and the arterial arcades and on the arcades; (3) *intermediate*, glands arranged around the trunk of the arteries, about midway between their origin and the gut; (4) *main*, glands arranged around the main trunk of the artery near its origin.

The 'intermediate' groups for the most part receive lymphatic vessels from the epicolic and paracolic groups, but some vessels may pass to them directly from the bowel itself. The 'main' groups receive chiefly

TECHNIQUE OF COLECTOMY

The removal of portions of the colon involves difficulties not encountered in similar operations on the small intestine. The more important of these depend on the fixation, location, vascular supply, and the arrangement of the lymphatic vessels and glands of the segment of bowel requiring to be resected.

1. *Fixation.* Comparative fixity, whether dependent on anatomical arrangement or on secondary infiltration, has in the past exerted a potent influence on the results of partial colectomy. Extended experience has demonstrated the freedom with which fixed portions of the colon may be mobilized by division of the parietal peritoneum at the outer margin of the bowel, which measure has done much to reduce the importance of this difficulty.

2. *Location.* The depth of the situation occupied by a growth leads to difficulties similar in nature to those of fixation, which are to be met also by free mobilization of the part requiring resection. Further, exposure of the field of operation may be rendered easier by a proper position of the patient during the performance of the operation, and removal of the affected part may be facilitated by the resection of a length of the intestine out of all proportion to that actually diseased. In spite of these aids, certain positions, such as that of growths situated deeply in the pelvis, still retain grave importance from a purely technical aspect.

3. *Vascular supply.* In this respect operations on the colon possess special characteristics, since the effect of obliteration of any main arterial trunk is known to correspond with a loss of vitality in a definite length of the bowel, and hence may determine with some exactitude the extent to be removed.

4. *The arrangement of the lymphatic vessels and glands.*

The subdivision of the system into areas corresponding with the main arterial trunks favours the possibility of dealing with the 'lymphatic area' in which the growth is situated in a more radical manner than is possible in the case of the small intestine, with its common supply from the large superior mesenteric artery.

Although colectomy may be demanded for the treatment of either simple or malignant conditions, yet the latter form the more frequent and important indication. Until recently no very definite rules have been laid down for the attempt to completely extirpate the lymphatic vessels and glands corresponding to the area occupied by colic tumours, such as have been propounded for the removal of carcinomata in other regions, as the breast and tongue, since the anatomical data on which such rules could be founded cannot be said to have existed. A valuable

these cannot be said to have been altogether unsatisfactory. The question, therefore, must arise as to when it is justifiable to submit patients to the increased risks involved by the employment of the more extensive operations designed for the radical removal of the 'lymphatic area' concerned, and the points which affect this decision must be shortly considered.

1. *The extent of the local disease.* Surrounding infiltration or the existence of adhesions is as fully opposed to an extensive as a limited operation. Under such conditions, even if adhesions can be dealt with locally by the removal of a portion of adherent bowel, yet it is improbable that the necessary additional removal of the second series of glands could be satisfactorily proceeded with.

2. *The position of the growth with regard to the blood-supply.* It is at once apparent, since the individual lymphatic areas correspond with those of the main arteries supplying any one segment of the colon, that the most extensive resections of intestine will be required when the growth occupies a point corresponding to the anastomosis of any two arterial systems—thus, at the flexures; also that the amount of bowel to be removed bears no sort of proportion to the magnitude of the tumour itself. The fact that these very extensive operations are indicated in situations in which experience appears to have shown the ulterior results of more limited operations to have been comparatively favourable, renders it necessary to exercise some caution before deciding upon their choice.

With regard to the regions in which special care needs to be taken in interfering with the arterial supply, it may be said these are few. Although certain anastomoses, notably that between the middle and left colic arteries, are occasionally absent, yet as a rule the intercommunication between the colic arteries has been shown to be sufficient to maintain the vitality of the bowel in spite of the obliteration of any one main trunk. Certain points are, however, worthy of mention. (*a*) Division of a main trunk is safe only if interference with the system of primary arcades is avoided. (*b*) In removal of the cæcum and ascending colon, division of the lowest ileo-colic branches endangers the vitality of the lower six inches of the ileum. (*c*) The general system of arterial arcades is interrupted between the lowest sigmoid branch and the highest branch of the superior hæmorrhoidal artery. As a consequence the anastomotic circulation in this region can only be maintained by a flow in the reverse direction in the lowest sigmoid artery itself to the superior hæmorrhoidal trunk. Thus Manasse (*Arch. f. klin. Chir.*, 1907, vol. lxxxiii, p. 999) has pointed out that a division of the inferior mesenteric trunk above the origin of this vessel is unattended by danger, while division of the trunk

vessels from the three peripheral groups, in certain regions, notably the lower part of the inferior mesenteric system, directly from the intestine itself, and on the other hand are connected centrally with the lumbar and mesenteric glands. The observations show that the complete removal of any given lymphatic area may be impracticable when infiltration of the 'main' glands has occurred, in consequence of their near connexion with the central system; also, that intercommunication between the colic

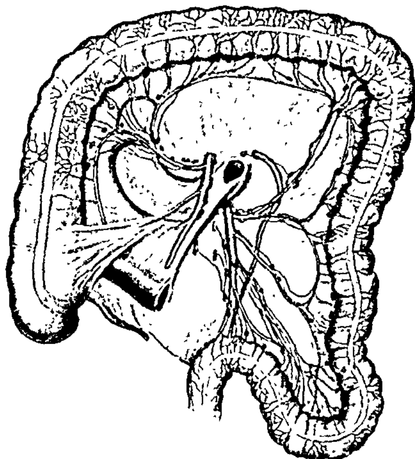


FIG. 215. THE LYMPHATICS OF THE COLON. The upper part of the pelvic colon, after Gegenbaur, has been added to show the interruption of the arterial arcades below the distribution of the lowest sigmoid artery. (*After Jamieson and Dobson.*)

systems and others, such as the splenic, may offer an obstacle to radical extirpation. On the other hand, they clearly indicate the lines on which complete operations should be planned, and are hence of very great value.

It is at the present time hardly possible to lay down definite lines for the choice of the major or minor operations described below, and in considering the suitability of either to individual cases great discrimination must be exercised. For simple conditions the minor procedures suffice, and even in malignant disease the ulterior results obtained by

necessitates a somewhat larger incision, and greater exposure of the abdominal cavity, yet, on the other hand, it renders manipulations easier and more rapid, while the risks of infection of the abdominal cavity are materially reduced. Again, the free removal of intestine in some situations rather facilitates than opposes the union of the divided ends.

Consideration of the above points seems to lead to the somewhat paradoxical conclusion that only the least extensive and apparently favourable cases are those suited to the more extensive methods of operation. Even if this prove to be the case, the results obtained by the more radical methods in other parts of the body indicate that a similar improvement is probable with the application of the same principle to the growths of the colon, and the general trend of surgical opinion is in this direction.

Putting the most extensive operations on one side, it is evident also that advantage may be gained by a systematic search for glands along the line of the vascular trunks in the retroperitoneal tissue, the more so as anatomical knowledge now permits us to determine with some precision the situation in which such glands should and should not exist, and which are of the greater importance. Such knowledge allows of a less extensive removal of the main arterial trunks, and this fact has influenced operators in somewhat limiting the scope of operations, which theoretically should be wider.

REMOVAL OF THE CÆCUM AND ASCENDING COLON

The cæcum shares with the sigmoid flexure certain characteristics; thus, in both portions of the bowel the intestinal contents tend to stagnate, and in both carcinomatous tumours are common. The cæcum differs from the sigmoid flexure in that its contents still retain highly digestive powers; hence perhaps an explanation that in the cæcum the medullary form of carcinoma is more common. The tumours are often large, with a tendency to ulcerate freely, and excite very considerable surrounding tissue reaction, leading to comparatively early fixation, often of a simple inflammatory character. Growths of the cæcum are also occasionally atypical in their structure, conforming rather to the type of an epithelioma than to that of a true columnar carcinoma.

Again, both these segments of the colon are especially liable to become the seats of inflammatory processes, sometimes accompanied by the formation of abscesses and fistulæ; tuberculous infiltration being more common in the cæcum, and simple inflammatory changes in the sigmoid flexure.

The cæcum may need removal not only when the disease is actually located in its walls, but also in many cases where the ascending colon is

below its origin endangers the vitality of the cut extremity of the lower segment of the bowel.

3. *The extent of glandular infiltration or enlargement.* The date at which this may commence is incalculable, but it appears probable that it occurs early only in instances of great malignity and rapid growth, such as are occasionally met with in young subjects. Butlin computed that more than 50 % of patients affected with colic carcinoma die from obstruction of the lumen of the bowel before glandular metastases have developed, and although this computation of freedom from glandular infiltration is probably too high, yet in Clogg's series (*loc. cit.*), although enlarged glands were found in a much larger proportion of the cases, in a considerable number the enlargement did not depend on cancerous infiltration, and this latter observation is confirmed by those of many other observers. Pathological evidence (Clogg) and clinical observation during the course of operations have shown that in certain positions, *e.g.* transverse colon and sigmoid flexure, and to a lesser degree at the other flexures, the glands affected tend to be those in the immediate vicinity of the growth, and these observations are supported by the normal course taken by the lymphatic vessels in relation to the glands demonstrated by Jamieson and Dobson. The observations of the latter authors of the course taken by the lymphatic vessels in the neighbourhood of the sigmoid and pelvic colons somewhat discounts the importance of this fact in that region, but, generally speaking, clinical evidence of the results of limited resections of the sigmoid flexure shows that it is not to be underrated.

Lastly, it must be remembered that the course of infection is by no means regular, and that glands may often be discovered at a distance from the growth, while those in the immediate proximity of it remain unaffected. Such enlarged glands are not necessarily carcinomatous, but the escape of the proximal glands has been clearly explained by the direct course taken by some of the lymphatic vessels to the intermediate glands by Jamieson and Dobson, and this fact, together with the observation that the intervening vessel is free from growth, moreover, is utilized by them as support for their contention that infection of the glands is embolic in character and not consequent on 'permeation'.

Infection of the 'intermediate' series of glands marks the limit at which a 'radical' operation is worth performance. If the 'main' series be infiltrated, the probability of existing extension to the mesenteric or lumbar glands is opposed to the likelihood of a radical removal being successful.

4. *The actual magnitude of the operation.* This factor is to be discounted, not only by the greater possibilities of permanent cure, but also by the operative advantages gained. Although the free removal of bowel

part of the procedure it is convenient to clamp the large vessels at some little distance from the margin of the colon before dividing them, as this measure diminishes the amount of bleeding and facilitates the detection of any enlarged lymphatic glands lying in their course. The retroperitoneal tissue in the area exposed should be cleanly removed from the posterior abdominal wall, especial care being taken that the ureter is not injured during the process of dissection.

The difficulties that may arise during the procedure of freeing the bowel may depend on inflammatory infiltration of the retroperitoneal tissue, or simple adhesions to neighbouring organs. Peritoneal adhesions are not uncommon when the disease is of an inflammatory or tuberculous nature, or in the florid medullary form of carcinoma; in the annular scirrhus form of growth, fixation due to malignant invasion of the retroperitoneal tissue may be very extensive compared with the small extent of involvement of the bowel itself.

The freed cæcum and colon are delivered from the abdominal cavity, and the uncovered retroperitoneal space carefully protected with gauze plugs prior to section of the small bowel. The ileum having been divided and duly cleansed, two courses are open: either to close both the proximal and distal ends of the bowel, and make a lateral anastomosis, or to close the colic end, and implant the ileum into the side of the colon. Axial union, although it has often been performed, is not to be recommended. Lateral anastomosis is the preferable method, and it is often more conveniently made to the transverse colon than to the more fixed remnant of the ascending colon, should this have been preserved.

When the free ends have been closed, the plugs protecting the retroperitoneal space are removed, and in order to bring the two portions of bowel into position for the anastomosis, it may be necessary to effect some rearrangement of the plugs which have served to retain the general abdominal contents during the operation. When satisfactory adaptation has been secured, the surrounding area is protected in the usual way and the union may be completed.

The last special step in this operation, closure of the defect in the posterior parietal pertioneum, is now proceeded with. When the removal of bowel has been extensive, this may be difficult, but it is rendered somewhat easier by the drawing upward of the mesentery which has accompanied the apposition of the ileum to the colon. The repair of the gap should be as complete as possible, since the opened-up retroperitoneal space is a source of great danger should infection have occurred. If it prove impracticable to entirely close the gap, it is usually advisable to introduce a drain from the loin, which may be removed at the end of from twenty-four to thirty-six hours.

the part primarily affected, since under the latter circumstances the cæcum is often much dilated, its walls are thickened, and the width of the lumen may render it unsatisfactory either for axial union or closure. Again, the close connexion of the lymphatic system of the two segments renders the removal of the cæcum a desirable proceeding, when the ascending colon is the seat of malignant disease. In some cases, however, where the growth occupies a high position in the ascending colon, the broad strong cæcum is well adapted for the lateral approximation of a loose transverse colon.

Anatomically these portions of the colon are in some respects favourably situated for operation; the cæcum itself lies ventrally, is surrounded by peritoneum, and the lower portion of the ascending colon is comparatively movable. In from 26 to 30% a mesocolon is present, but *the ascending colon becomes steadily less movable from commencement to termination. Occasionally the mesocolon is abnormally long, and then is continuous with the mesentery of the small intestine, a condition of much importance for the occurrence of the so-called cæcal volvulus.*

Operation. For removal of the cæcum or *ascending colon, the patient should be arranged with the right side of the body raised, and the pelvis higher than the abdomen, in order that the small intestine shall fall as far as possible out of the field of operation.*

The incision is made in the right semilunar line, and needs to be six or more inches in length. When the operation is done for malignant disease, a thorough exposure of the area to be dealt with is of more importance than the final condition of the abdominal wall; hence no limitation of the length of the incision is advisable, the more so as free access to the parts not only renders the subsequent manipulations easier, but also diminishes the risk of infection.

The portion of bowel requiring removal having been exposed and defined, the points at which division is to be effected are decided upon, and plugs are introduced to isolate the area of operation from the general peritoneal cavity.

If necessary, the bowel is mobilized by division of the parietal peritoneum at its outer margin, the colon being raised together with the retroperitoneal tissue, and drawn forwards and inwards. This process involves little hæmorrhage, as the main vessels reach *the intestine at its inner margin and only anastomotic branches are involved.*

Clamps are applied *on either side of the two points to be divided,* and the removal of the included portion of bowel proceeded with. It is generally more convenient to first divide the distal end of the colon, and the cut ends having been carefully cleansed and wrapped in gauze, the part to be removed is rapidly freed in a downward direction. In this

anastomosis between the two portions of the gut was effected, thus drawing up the mesentery and covering in the denuded area on the posterior abdominal wall. A small tubular drain was inserted through a stab wound in the loin and the anterior wound was closed in the usual way.'

Dobson claims by this operation to 'remove all the primary lymphatic glands receiving direct vessels from the cæcum and ascending colon, the lymphatic vessels, and the tissue in which these vessels run. The blood-supply of the portion of intestine to be removed is effectively controlled, and the risk of contamination of the field of operation is minimized by deferring the division of the gut until towards the end of the operation.' The removal of several inches of the ileum enables the small intestine to be brought up to the colon with ease, and allows of a satisfactory anastomosis being performed. Division of the transverse colon at the junction of the middle and right thirds is now recommended.

REMOVAL OF THE TRANSVERSE COLON AND THE FLEXURES

The hepatic flexure is not very commonly (6·4%) the seat of tumours; when present they are comparatively easy to deal with, since the flexure, although fixed, is uncovered and near the anterior abdominal wall. The acuteness of the flexure and the length of the mesenteric attachment fluctuate considerably. A variable fold, corresponding with the costo-colic ligament of the left side, extends from the flexure to the abdominal parietes, and occasionally folds stretch from it to the liver and stomach.

Operation. The incision may be made through the right rectus sheath, or in the semilunar line. The procedure is considerably facilitated by placing an air-cushion or pillow under the back of the level of the lower ribs (as in an operation on the bile passages); this manœuvre not only renders the flexure more prominent and easily extruded, but also favours the falling away of the small intestine from the field of operation. Union of the two ends of the colon by lateral anastomosis is the preferable method of junction.

The writer's experience of a limited operation in this region has been a favourable one; thus one patient is alive and well at the end of fifteen years, one survived four years before a recurrence took place, and a third remains well after a short period. But both Jamieson and Dobson, and Clogg, recommend an extensive removal for growths in this situation. They consider it advisable to remove the whole lymphatic area corresponding to the distribution of the middle colic artery. The middle colic artery is isolated and tied at its origin, and the mesocolon incised from this point to the extremities of the parts of the intestine supplied

Dobson (*Lancet*, 1908, vol. i, p. 149) gives the following description of an operation performed for the removal of a carcinoma of the ascending colon, together with the corresponding 'lymphatic area':—

'An incision 7 inches long was made in the right linea semilunaris, the tumour in the ascending colon was defined, and the small intestine was packed off to the left side of the abdomen. The duodenum and the ileo-colic vessels were then defined, the overlying peritoneum was divided, and a fairly large uppermost gland of the main ileo-colic group chain was pushed downwards. The artery and vein were then clamped and ligatured, the ligature being applied about ½ inch from the superior mesenteric artery. At this stage clamps were applied to the transverse colon close to the hepatic flexure, and to the ileum about 6 inches from the ileo-colic valve.

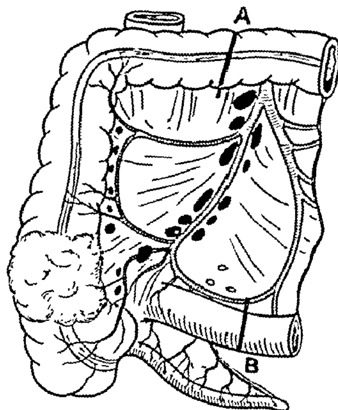


FIG. 216. ILEO-COLIC LYMPHATIC AREA WITH A COLIC GROWTH. The division of the colon, A, is that now recommended, but somewhat wider than that described in the above operation. B, Point of section of the ileum. (*Dobson.*)

'The peritoneum on the outer side of the ascending colon was then divided, and the whole mass—ascending colon, cæcum, and terminal portion of the ileum—was thrown over to the left, the peritoneum, ileo-colic vessels, and chain of glands being stripped off up to the duodenum; the ureter was seen and avoided and some vessels were tied. The mesocolon was then divided from the duodenum to the selected point on the colon, some branches of the middle colic artery being tied. In the same way the peritoneum of the anterior layer of the mesentery was divided down to the ileum, and also the posterior layer and the terminal branch of the mesentery artery were secured. The whole mass was now easily withdrawn from the abdomen (see Fig. 216), and the colon and ileum were divided between clamps; both ends were closed by celluloid thread continuous suture, three layers in the colon and two in the ileum. Lateral

detection, even during an abdominal exploration, when much distension existed.

These peculiarities render a vertical incision inconvenient, the flexure being most satisfactorily exposed and mobilized from an incision made obliquely along the left lower costal margin 6 inches in length.

The tumour having been removed, the form of union may be a difficult question to decide. The descending colon lies deeply, and in cases of carcinoma of the splenic flexure is often contracted and small. End-to-end union is dangerous and unsatisfactory ; lateral union may be difficult, but if practicable is to be chosen.

The difficulty lies in the fact that while the transverse colon is provided with a mesentery, mobility may be insufficient to allow it to be conveniently placed alongside the fixed descending colon, and the necessary sewing may have to be carried out within the confines of the abdominal cavity. If the descending colon cannot be sufficiently mobilized to facilitate union, the trouble may sometimes be met by closing the cut ends and uniting the transverse colon laterally to the sigmoid flexure. Lateral implantation of the descending colon into the transverse has, in the hands of the writer, proved itself an unsatisfactory method, as in two instances in which it was adopted secondary stenosis occurred, necessitating the formation of a proximal vent.

Madelung (*Archiv. f. klin. Chir.*, 1906, vol. lxxxi, Pt. 1, p. 206) has expressed the opinion that the prognosis after removal of growths of the splenic flexure is especially good, even if the disease be advanced, on account of the paucity of the lymph paths, and that metastases are comparatively uncommon. Jamieson and Dobson, on the other hand, express an opinion in favour of a wide removal of this flexure, as in the case of the hepatic. They observed the large majority of the lymphatic vessels to pass into the epicolic and paracolic glands, rarely to the intermediate group, and never directly to the main groups situated on the left colic artery or on the upper part of the inferior mesenteric vein. Some lymphatic vessels were, however, observed to pass to the splenic glands, hence a complete removal of the lymphatic area is impracticable.

Removal of the growth, together with that part of the lymphatic area connected with the branches of the left colic artery, is recommended. The left colic artery and vein are to be defined as they leave the outer margin of the inferior mesenteric vein, and tied. The splenic flexure, together with the left third of the transverse colon, and the greater part of the descending colon are to be mobilized and removed, and an axial union established. This operation, although extensive, has the great advantage of avoiding the difficulties of union above mentioned to a considerable degree.

by this vessel. This necessitates the removal of the upper third or half of the ascending colon, and of two-thirds of the transverse colon. The widely separated cut ends are closed, and an ileo-sigmoidostomy performed; or the lower part of the ascending colon, the cæcum, and the lowest six inches of the ileum are to be removed, and the ileum is anastomosed with the remaining third of the transverse colon.

The operation is wide, but it is claimed that it permits of free mobilization of the growth, complete control of the blood-supply, allows the intestine to be brought well out of the abdomen with corresponding diminution in the risk of contamination of the field of operation, and allows of the anastomosis of movable portions of the gut widely removed from the seat of disease.

The transverse colon. The existence of a long mesocolon much simplifies the operation of colectomy in this segment, especially in its left half. It is well to bear in mind that the mobility of the bowel allows considerable range of position, which may allow a tumour to descend so low as to be mistaken for one of the sigmoid flexure before it is exposed. The transverse colon is readily united axially, the usual precautions being taken with the mesenteric angle. The glands arranged along the branches of the middle colic artery are favourably situated both for detection when enlarged, and for removal; but caution must be exercised, in dealing with the central parts of the mesentery, that the superior mesenteric artery be not damaged. This portion of the bowel is also especially well situated should it be wished to make use of an omental flap to cover a union of doubtful stability.

The observations of Jamieson and Dobson go to show that the intestinal lymphatic vessels are all intercepted before they have run very far by the 'paracolic' glands, while the 'intermediate and main' groups of glands receive no vessels directly from the gut. Under these circumstances they only consider it necessary to remove as much colon on either side of the growth as to permit of a satisfactory anastomosis, the paracolic glands at some little distance from the growth being secured together with it.

The splenic flexure is deeply situated, and enterectomy in this position is more difficult of performance than in any other, except in that of the pelvic colon. The flexure is more constant than the hepatic, as might be expected from the fact that it perpetuates one of the primary developmental bends of the alimentary tube. The bend is usually acute, lies directly upon the left kidney, and is fixed in position by the costo-colic band. A mesocolon is present in only 5 % of all cases.

The deep position, and the fact that this segment of the bowel is particularly often the seat of typical annular growths, render the localization of tumours in this region very difficult, so much so that they have escaped

38% of all cases of carcinoma of the colon, excluding the rectum, and in this segment the growths show a special disposition to assume the annular form, and to be circumscribed in area. When situated at the distal portion of the loop, they lie within the pelvis and are difficult to palpate, but in such cases help in diagnosis may often be obtained by noting thickening in the proximal portion of the bowel, the collection of considerable masses of scybala, or well-marked local peristalsis. Growths of small size may be visible on exploration with the long proctoscope or sigmoidoscope. Again, growths, impalpable from above, may often be discovered by bi-manual examination *per vaginam* or *per rectum* in the female, or *per rectum* in the male. When the growths are of the pronounced annular form, and situated in the lower part of the loop, an exploratory incision is often the only method of actually palpating them, and in cases where the growth has acquired firm adhesions to the pelvic wall, even if it be of considerable extent, a very moderate amount of distension of the bowel or a thick abdominal wall renders an open exploration the only means of digitally determining its presence.

Operation. The patient should be arranged in the high Trendelenburg position with the left shoulder and side of the pelvis somewhat raised by pillows. The incision is made in the left linea semilunaris, or often better through the left rectus sheath, since the more difficult end of the bowel to manipulate, the distal, lies fairly mesially. Should difficulty arise in dealing with the upper end, the incision may be enlarged towards the left, the line of cleavage of the fibres of the broad muscles of the abdomen being followed when the limits of the rectus sheath are depassed.

The exposure of the tumour is easy if the growth be situated in the central portion and provided with a long mesentery; more difficult, if the part to be removed is at the upper or lower part and the mesentery is short.

The bowel itself along the mesenteric margin and the mesentery in the lines of the arteries are palpated for the detection of enlarged glands, and the amount of bowel to be removed is decided upon. The general abdominal cavity is protected by the insertion of plugs, and the retention clamps are applied to the bowel. If necessary, the bowel is now mobilized by an incision made into the mesentery at its outer line of continuity with the parietal peritoneum, and the excluded loop is drawn forward and removed, together with a portion of the mesentery and such enlarged glands as shall have been discovered. Hæmorrhage may be minimized by securing the large sigmoid branches prior to section of the bowel.

Union may be of the type axial variety, or the ends may be closed and a lateral anastomosis established. The latter method is preferable should any doubt exist as to the healthy condition of the bowel-wall.

The descending colon. Tumours in the descending colon are rare (3·1–7·1 %), possibly since this portion of the large bowel serves less as a reservoir and there is little tendency of the contents to stagnate. After leaving the splenic flexure the fæces descend rapidly, peristalsis being aided by the force of gravity from the straight vertical course taken by the bowel. In fact, at post-mortem examinations the descending colon is rarely in a state of distension.

The difficulty of a limited colectomy here comes next in order of gravity after the splenic flexure, and, for much the same reasons, depth and fixity. A mesocolon is met with more commonly than in the case of the ascending colon, partly as a result of the lesser degree of distension. The isolated blood-supply, and consequent simple arrangement of the lymphatics, makes the removal of glands less difficult than in the case of the cæcum and ascending colon. According to Jamieson and Dobson, the lymphatic area comprises the epicolic and paracolic glands, and the intermediate glands on the branches of the left colic and first sigmoid arteries; as in the case of the splenic flexure, a communication with the splenic system exists. The operation recommended corresponds with that for removal of the splenic flexure, except that the lower division is of the upper part of the sigmoid flexure instead of the descending colon, and the first sigmoid artery is tied close to its origin.

The sigmoid flexure. This segment of the colon is a more common seat of surgical operation than any other. Malignant growths are frequent, while the function of the loop as a reservoir makes it particularly liable to the occurrence of inflammatory changes. On the whole the arrangement of the sigmoid flexure is singularly constant, although in common with a general transposition of the viscera it may occasionally lie to the right side of the body; and rarely, it may be absent, the descending colon terminating in a direct continuity with the rectum, in which latter case a large cloaca is sometimes developed to take place in the higher reservoir which should normally exist. The loop may vary in width, length, and degree of convolution, but the most important practical variations are dependent on the relative length of the mesentery. Congenital cicatricial bands and lateral adhesions are occasionally met with, while a short mesentery, especially with a distended loop, may equally be a mere individual anatomical arrangement. Either of these conditions may give rise to operative inconvenience, even when the flexure itself is not the actual seat of the disease; but the most frequent source of difficulty lies in the shortening of the mesentery so frequently accompanying the presence of malignant tumours and inflammatory conditions. A long mesentery favours the occurrence of volvulus.

The sigmoid flexure is the seat of malignant disease in from 27 to

segment of the bowel concerned, they recommend the following operation for growths of the lower part of the sigmoid colon.

The inferior mesenteric artery and vein are exposed and tied immediately *below* the origin of the left colic artery. A long incision is made at the outer side of the mesorectum and mesosigmoid, and the descending colon and sigmoid mobilized by stripping them inwards towards the middle line. In doing this the ureter and spermatic vessels will be encountered and must be avoided. The mesosigmoid is then divided in an oblique line downwards from the point of ligature of the inferior mesenteric to about the middle of the sigmoid flexure, care being taken to preserve as far as possible the secondary arches on the sigmoid arteries. The peritoneum to the inner side of the artery is divided downwards to the inner side of the mesorectum. The mass of tissue to be removed is then stripped forwards from the upper part of the sacral hollow, and the gut clamped and divided at the middle of the sigmoid flexure and at the junction of the first and second parts of the rectum. The part removed will consist of the lower half of the sigmoid flexure and the upper part of the rectum, the greater part of the inferior mesenteric vessels with the accompanying chain of glands and lymphatic vessels, and the surrounding subperitoneal tissue.

The blood-supply of the upper end is assured, owing to the preservation of the left colic artery, that of the lower, which depends on the middle and inferior hæmorrhoidal arteries, suspect (see p. 455); it must be tested by release of the clamp. If no bleeding occurs, one of two courses must be taken: (*a*) to complete the operation by a colostomy; (*b*) to remove more of the lower portion, everting the rectum and drawing the freed sigmoid down through the anus to perform a union by Maunsell's method. If, on the other hand, the lower end bleeds, an immediate suture *in situ* may be performed.

For the middle and upper parts of the sigmoid flexure they point out that an equally severe operation is necessary to secure the ideal, but in view of the fairly satisfactory results obtained in the past by partial operations they recommend a modified operation.

The peritoneum is divided over the inferior mesenteric vessels, and as many of the main glands are stripped off them as is possible without damaging the vessels. This is done from the point of origin of the left colic artery down to the origin of the lowest sigmoid artery. The sigmoid arteries are tied at their origin, the lowest being preserved if its removal be not necessitated by the position of the growth. The descending colon is then mobilized by an incision of the peritoneum at its outer border and the gut divided above at the junction of the descending colon and the flexure, and below in the lower part of the flexure. Almost

When any question arises as to the efficiency of the suture, either from the actual condition of the bowel-wall, the tension existing on the union, or the general state of the patient, it is often possible to make the line of suture extra-peritoneal. In the early days of intestinal surgery this was often done, by retaining the loop of bowel, when long enough, without the limits of the abdominal cavity, and either allowing it to sink, or replacing it at a later date when union had taken place. If the loop was too short to allow of this procedure, the wound was plugged down to the seat of suture and not entirely closed. Both these procedures are open to objection, and have been much improved upon by the method employed by Bloodgood.

'The parietal peritoneum is separated from the margins of the wound for a sufficient distance to allow it to be pushed back and sutured to the mesentery of the bowel on each side of the suture. Above and below, the margins of the peritoneum are brought together as usual, thus securing the line of suture in an extra-peritoneal position at the bottom of the external wound, a gauze drain being inserted down to the bowel.' In the case related 'the method protected the peritoneal cavity most effectively, but no leakage from the line of suture occurred; the wound granulated up rapidly' (*Trans. Amer. Surg. Assoc.*, 1906, vol. xxiv, p. 115).

When the growth occupies the lower extremity of the flexure, or if a considerable length of bowel has needed removal, great technical difficulty may arise in the union of the remaining bowel ends. Under these circumstances two courses are open, the simplest to utilize the upper end for a colostomy, and sew up and sink the lower into the pelvis. When the difficulty depends on fixation of the upper segment this course is the safer and to be preferred.

When the difficulty depends on the shortness of the lower segment, a colostomy may be avoided if desired in the manner suggested in the next operation (see p. 467).

Jamieson and Dobson in dealing with the sigmoid flexure and upper part of the rectum state that the glands implicated are those of the para- and epicolic groups, the intermediate group upon the sigmoid arteries, and the main glands on the inferior mesenteric trunk. They did not observe the passage of any lymphatic vessel *direct* to the glands at a higher point on the inferior mesenteric trunk than that corresponding with the middle and upper thirds, *i.e.* just below the origin of the left colic artery. The proximity of the inferior mesenteric trunk to the bowel in the lower part of its course practically necessitates the removal of some portion of the vessel, but considering the paramount importance of the left colic artery for the anastomotic circulation of the upper

tration of the serum on the appearance of signs of serious infection has shown that it may influence the general and local symptoms much as it does in appendical peritonitis.

Thus, a man aged 52, from whom an extensive carcinoma of the ascending colon was removed, and an axial enterectomy performed, passed a sleepless night in spite of morphine, and on the following day the pulse had risen to 130, and the temperature to 103·6° F. The respiratory movement of the abdominal wall was very restricted, local tenderness and some distension developed, and there was great pain. An injection of 25 c.c. of anti-colon bacillus serum was given at the end of twenty hours, followed by a second at the end of a further twelve hours. The first injection was followed by a fall in the pulse to 116, the temperature to 100·4°, relief of the pain, and comfortable sleep. Two injections were given, and after the third day no further alarming symptoms were observed. On the eighth day the temperature rose, and signs of intraperitoneal abscess were discovered. Incision and drainage of the abscess were followed by rapid recovery. This case followed the same course often seen in bacillus coli infections in connexion with acute perforations of the appendix, both as to the relief of general symptoms of septicæmia, and in the occurrence of rapid localization of the area of infection.

2. When the resistance of the patient is good, or the infection of minor degree, local abscesses may develop. These abscesses usually do well, if early and freely incised and drained, and, except for the possible formation of a fæcal fistula and the increased risk of the development of permanent local adhesions, may do little harm. Those situated in the retroperitoneal space are the more difficult to deal with, and give rise to the more chronic form of fistulæ.

Failure of the suture. Apart from deficiencies in the actual technique, this accident may be the result of several causes, and may also be followed by general infection of the peritoneal cavity, or the formation of a localized suppuration.

The suture may give way at the point in the line of union in which the peritoneal investment of the bowel is deficient. This has been most commonly seen in axial unions of the ascending and descending colons, less frequently in the small intestine, since improved methods of closure of the 'mesenteric angle' have been devised.

The stitches may cut through the included tissue as a result of deficient vitality of the bowel-wall, or as a consequence of the regidity of the tissue dependent on inflammatory infiltration. The latter fact gives a useful warning against drawing the sutures too tight when such conditions of the bowel exist.

The general condition of the patient may be such that a sufficient

the whole of the *mesosigmoid* will thus be removed, including the intermediate paracolic and epicolic glands, and probably the greater number of the main group corresponding to this part of the sigmoid flexure. If it be found necessary to tie the lowest sigmoid artery at its origin care must be taken to divide the gut below the level of the brim of the pelvis, in order to avoid the 'dead end' which may be left, as Manasse and Archibald have shown, owing to the non-union of the branches of the lowest *sigmoid* and *superior hæmorrhoidal* arteries.

Moynihan (*Surg. Gyn. and Obst.*, 1908, vol. vi, p. 463) gives a full description of similar extensive operations carried out by himself, the main features of which lie in the free mobilization of the bowel which he shows to be practicable, and the free removal of lymphatic glands. An equally extensive operation has been devised by Kümmel (*Arch. f. klin. Chir.*, 1899, vol. lix, p. 555) on the ground of possible inefficiency of the vascular anastomoses when the lower colon is extensively resected.

ACCIDENTS SUBSEQUENT TO, AND AFTER-CONSEQUENCES FOLLOWING, ENTERECTOMY

Primary peritoneal infection. This, the most frequent and fatal complication of enterectomy, has become less frequent as one-stage operations have been abandoned in the presence of serious obstruction. It is *most commonly the result of infection during the performance of the operation*; less often, of a *primary incompetence of the suture*. Death from this cause is usually rapid, occurring in the course of from two days to a week.

Whatever mode of operation is adopted, the risks of infection during its performance cannot be entirely obviated, but the danger steadily increases with the degree of fixity of the portion of bowel involved, and consequent necessity of performing the section of the lumen within the confines of the peritoneal cavity, also with the relative amount of intestinal contents. Infection is greatly more to be feared during the performance of colectomy than in enterectomy of the small intestine, and the chances of its occurrence increase with the degree of fluidity of the fæces contained in the large bowel. The mechanical difficulty due to fixation must be met as far as possible by free mobilization of the part of the bowel concerned. When circumstances appear to render the occurrence of infection probable, it is to be met by the provision of free primary drainage at the time of operation, and prompt opening up of the wound should the drainage prove insufficient to prevent diffusion.

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of the intestine may result, leading to the necessity of a further laparotomy and possibly to the death of the patient.

Stenosis at the seat of union. As an immediate sequence of enterectomy this complication has practically disappeared with the introduction of improved technical methods. When a later consequence it has more frequently been observed after axial unions and lateral implantation than after lateral junctions of the bowel.

PROGNOSIS AND RESULTS OF ENTERECTOMY

Whatever form of enterectomy be undertaken, the operation must rank as one of the more formidable of surgery. Although isolated small series of cases showing a very low rate of mortality have been published by individual operators, yet if the records of a large number of eminent surgeons be reviewed the death-rate after this operation cannot be placed below 30 %. Anatomical conditions render resection of the small intestine a less serious procedure than that of the large, while the nature of the contents of the bowel is more favourable for the safe conduct of the operation; on the other hand, resections of the small intestine often have to be performed under most unsatisfactory conditions.

Two factors mainly influence the prognosis after an enterectomy: (1) the danger of infection during the performance of the operation, (2) the nature of the conditions for which it is undertaken. In the light of present experience it is difficult to see how the risks of immediate infection are to be further greatly diminished, although it is clear that attention to technical details is the predominant factor in obtaining the best results, and that obvious improvement in results has been observed to accompany the more efficient protection of the general peritoneal cavity during the performance of the suture, such precautions as the removal of a sufficient length of the bowel, preliminary mobilization of the large intestine, and perfectionment in the methods of suture itself. As to the second factor, putting aside operations done in the presence of deficient vitality from acute conditions, the nature of the disease is seen to exert a very definite influence on the results attained. Thus, while the mortality in malignant disease has not been brought to below one-third of the whole number of cases, the proportion of failures in enterectomies performed for tuberculosis has been materially reduced.

Remarks will be found elsewhere as to the recorded results of enterectomy for such conditions as result from strangulation of the bowel, but it may be mentioned here that one important factor in the improvement of results has been the removal of sufficient lengths of bowel to

deposit of plastic material for the satisfactory closure of the wound is not provided, especially where malignant disease is the primary trouble. Again, the plastic material primarily effused may not be converted into properly organizing tissue, or under these circumstances may become reabsorbed. The latter process is specially likely to occur in the presence of peritoneal infection. In this relation the observations of Chlumsky are of much interest; he has shown that the union of intestinal wounds is firmer upon the first than upon the three following days, that from the fifth onwards the strength steadily increases, while at the seventh it should be thoroughly secure (Kocher, *Chir. Oper.*, p. 937).

Local stitch abscesses may form in the line of union as a result of infection of the suture thread. Speaking generally, the possibility of this accident is an argument against the employment of a single tier of through and through sutures when circumstances do not make it a necessity.

When lateral unions are made, the closed ends of the bowel may give way secondarily. Some remarks have been already made on this subject under the general heading of Enterectomy. The accident appears to have happened much more frequently after the excision of the bowel tumours than where the ends have been closed in the performance of unilateral exclusions, a fact probably to be explained by the greater time needed for the performance of the former operation, and the much greater amount of interference with the vascular supply of the intestine involved. This observation serves to impress the necessity of keeping the possibility of this accident well before us in the performance of colectomies. The eighth or ninth day is that on which failure is prone to occur, and care must be exercised in the exhibition of purgatives, or still more, the administration of enemata at this period.

The formation of a local abscess in connexion with the suture is not necessarily a serious matter to the patient, either as to danger to life, or great prolongation of the length of treatment, but it is important, as probably leading to the formation of adhesions which may permanently prejudice the viability of the channel in the bowel, interfere with normal peristalsis, and possibly give rise to ulterior obstruction of neighbouring coils of intestine.

The formation of immediate adhesions. Adhesions may develop between the actual seat of union and adjacent coils of small intestine, between the seat of union and the abdominal parietes, or between coils of small intestine in the neighbourhood of the enterectomy. Such adhesions naturally form most frequently in the presence of infection, but more especially when the infection is a slow one, due to leakage from the line of suture from whatever cause Acute obstruction from kinking

Without doubt, these statistics contain a large number of patients operated upon under unsatisfactory conditions, but none the less they set out the immediate mortality which has been experienced up to the present time.

Anschütz (*Mittheil. aus. d. Grenzgeb. d. Med. & Chir.*, 1907, III Suppl.) in a report from the Klinik of von Mikulicz records 20 one-stage operations for carcinoma with 11 deaths, while of 30 cases treated by the several stage operation, only 6 died. He further states that, including the results of other surgeons, the mortality of the several stage operation has not risen beyond 12%, while among 139 one-stage operations collected from the literature the mortality reaches 46%.

In 27 of the above 30 cases which were able to be followed subsequently, 14 patients remained well and free from recurrence at the end of three years, or 52%.

ensure the tissues in the line of union being healthy. Thus, of sixteen cases recorded by Roswell Park (*Centralbl. f. Chir.*, 1904, p. 55), in which more than 200 centimetres of gut were removed, only four, or 25 %, died.

Enterectomy for inflammatory conditions has been followed by fair results, but even here we find as large a proportion as two deaths among five operations performed on the sigmoid flexure by W. J. Mayo (*Trans. Amer. Surg. Assoc.*, vol. xxv, p. 237).

In Hartmann's collation of enterectomies for tuberculous disease (*Trans. Med. Soc. of Lond.*, vol. xxx, p. 334), he finds that of 75 operations performed before 1900, 22, or 30 %, died, while of 58 operations after that date only 7, or 12 %, died, a difference no doubt resulting from the more careful choice of cases on the one hand, and improved technique on the other. Caird (*Scot. Med. and Surg. Journ.*, vol. xiv, p. 22) has published a series of 11 operations with 7 recoveries. Nikoljski (*Centralbl. f. Chir.*, 1904, p. 395) has collated 130 cases of operation for tuberculous stenosis, mostly in the cæcal region, in which the mortality after enterectomy was 30 % and after anastomosis 17 %.

In malignant disease the immediate prognosis is grave, but the ultimate results are fairly satisfactory, since it may be fairly asserted that patients from whom the growth has been removed, even if they only survive a period of months, are in a happier condition than those who have been subjected to colostomy, while a good proportion may remain free from trouble for years.

The late date at which sarcomatous tumours are detected militates against satisfactory results. Lacène (Hartmann, *Chir. de l'intestin*, p. 433) gives the mortality in 25 cases subjected to enterectomy as 25 % (adults, 18 axial unions with 7 deaths (33·3 % mortality); lateral unions, adults, 4, no death; children, 3 axial unions with no death). Eight of these patients remained alive and well at 8 years, 4 years, 3½ years, 2 years, 1½ years, 1 year, 10 months, and 8 months respectively. Moynihan (*Abdominal Operations*, 1st ed., p. 323) in his collation, which contains several of the same cases, reports similar results. Corner and Fairbank (*Trans. Path. Soc. of Lond.*, 1905, vol. lvi, p. 20) have collected 13 cases of sarcoma of the large intestine subjected to enterectomy, with a mortality of 46·1 %.

The following table contains the recorded results in 276 enterectomies for carcinoma. In all 104 died, a mortality of 37·6 %.

Collected by Hartmann .	143	died 48	Mortality 33 5 %
St. Thomas's Hospital .	58	,, 23	,, 39·5 %
Voelcker, Czerny's Klinik	58	,, 27	,, 46·5 %
Caird	17	,, 6	,, 35·2 %

When obstruction is acute it is rare that either of these indications can be safely acted upon, both on account of the danger which depends on the highly septic character of the abundant intestinal contents, and the unsatisfactory conditions offered by the stretched bowel-wall for the purposes of suture. Should the procedure be taken into consideration in dealing with such cases, the amount of distension and the power of contraction still possessed by the intestinal muscle are the two local conditions which, combined with the general state of the patient, must decide the question; but as a rule anastomoses are only desirable when the signs of obstruction are of minor degree or chronic in character.

3. *In cases of tuberculous disease* of the intestine, especially in the entero-peritoneal form and in the small gut, a lateral anastomosis is often preferable to an exclusion in view of the difficulty which may exist in determining the upper and lower ends of the portion of bowel affected in the presence of numerous adhesions. In these cases, moreover, more than one anastomosis may be desirable.

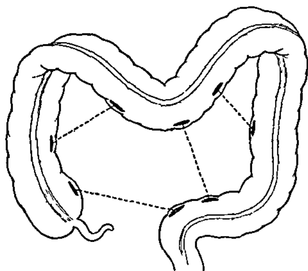


FIG. 217. SOME POSITIONS IN WHICH COLO-COLOSTOMY MAY BE PERFORMED. (*Modified from Hartmann.*)

4. Lateral anastomosis may be employed as *a preliminary to the closure of an artificial anus or fæcal fistula* by suture or enterectomy. On subsequent closure of the ends a lateral enterectomy is obtained.

5. *In cases of gangrenous hernia* a lateral anastomosis is sometimes performed at the base of the loop, the gangrenous apex being drawn out of the wound and left for future treatment (Roux's operation).

6. Lateral entero-anastomosis forms a portion of the operation in some forms of gastro-enterostomy and jejunostomy.

In the choice of the most suitable situation for the establishment of an intestinal anastomosis, certain points are open to consideration. When possible a spot should be selected at which the bowel-wall is as far as possible in a normal condition; while, when the disease for which the operation is performed is malignant in character, the new communication should be sufficiently widely removed from the primary disease to render secondary invasion of the opening improbable. The situation of the

CHAPTER X

LATERAL INTESTINAL ANASTOMOSIS AND EXCLUSION

SIMPLE LATERAL ANASTOMOSIS

THIS procedure repeats the natural process observed in the formation of spontaneous communications between neighbouring coils of intestine or other tubes. Originally devised by Maisonneuve in 1845, it resulted in two failures, and probably on this account the operation received no support and little consideration until the question of its utility was raised by Hahn some forty years later. The practical application of the method dates from the publication of the interesting and instructive work of Senn in 1889, and to his able advocacy the now frequent employment of methods of lateral anastomosis is due.

Simple lateral anastomosis has more recently suffered some limitation in its field of application by the introduction of the methods of exclusion. Practical experience has shown that a lateral opening in the delivering segment of the bowel is insufficient to wholly divert the passage of its contents into the distal receiving one. When the operation is designed to overcome the obstruction due to a stenosis this defect may lead to undesirable collections of intestinal contents in the short-circuited portion of the bowel; while, if the anastomosis is made to favour the closure of an intestinal fistula, or with the desire to entirely divert the passage of intestinal contents from the normal channel, it fails in its object. This failure depends in part on the natural tendency of the fluid contents of the various canals in the body to travel in their usual course if possible, in part on the tendency of the anastomotic openings to contract when an alternate route exists.

Indications. 1. Cases of *chronic obstruction* of the bowel by growth, unsuitable for any more extensive or radical measure. If performed for this cause, the undesirable collection of intestinal contents in the short-circuited segment may be met by the establishment of a fistula in this part of the bowel, or, in suitable instances, by the addition of an appendicostomy, to allow a vent for gas and the possibility of flushing out the interior of the excluded portion of the intestine.

2. A lateral anastomosis may be employed *as a preliminary measure to the performance of an enterectomy*, forming a desirable substitute for a preliminary colostomy.

away from the original operation wound (see Fig. 219). This method is convenient in cases in which it is desired to treat the interior of the excluded segment with medicaments, and it has been found by experience that only the distal opening remains of any material size, the normal peristalsis directing the discharge of contained matter in the habitual direction.

The method of unilateral exclusion is more widely employed, although it is not altogether free from the objections that have been raised against simple anastomosis. A tendency still exists for the accumulation of intestinal contents, especially gas, which enter the excluded portion of

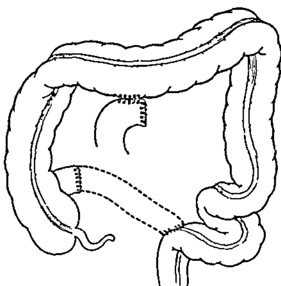


FIG. 218. METHOD OF MONPROFIT. The proximal end of the ileum has been anastomosed to the transverse colon. The dotted line shows the distal end of the ileum implanted at the upper end of the pelvic colon. (*Modified from Hartmann.*)

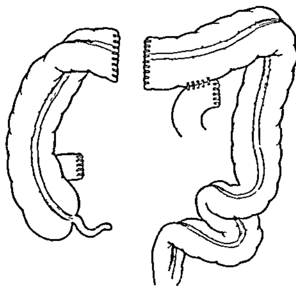


FIG. 219. BILATERAL EXCLUSION. Ends of the excluded segment closed. The ends may be treated in other manners. (1) They may be brought up and sutured into separate special openings made in the abdominal wall. (2) A vent may be established in the cæcum, or by an appendicostomy, and the distal end of the excluded segment brought to the surface. (*Modified from Hartmann.*)

bowel by reflux from the point of anastomosis. This occurrence has been denied by Roux, who states that it occurs only when an intestinal fistula exists in the excluded portion, and interferes with the normal peristaltic action. Roux's theory has not, however, been substantiated by other observers, hence the temporizing expedient of establishing a vent at the proximal end of the excluded segment from which the bowel can be periodically flushed out has been introduced. In other instances the difficulty has been met by excising the whole portion of bowel excluded, the parts in some instances amounting to almost the entire length of the colon.

anastomosis should be so chosen as to avoid the production of any undesirable degree of tension on the joint. Thus, an ileo-colostomy or ileo-sigmoidostomy is as a rule superior to any form of colo-colostomy, because the comparative mobility of the small intestine allows it to be placed practically in almost any position without strain. Colo-colostomy may be said to be generally undesirable if it can be avoided, for in addition to the question of fixation of the colon it is to be remembered that the peristalsis is comparatively weak in this portion of the bowel, and hence the chances of an efficient anastomosis are diminished (see Fig. 217). Published results show that a greater proportion of failures have attended the establishment of colo-colostomies than of anastomoses between the small and large bowel.

Operation. The technique of uniting the bowel in lateral anastomoses differs in no way from that already described on p. 442, under the heading of Lateral union in enterectomy (see Figs. 204-6). The importance of ensuring an iso-peristaltic union should be borne in mind.

METHODS OF EXCLUSION

Since the advocacy of total exclusion by Salzer in 1889 (*Verhandl. der Deutsch. Gesellsch. f. Chir.*, 1891, vol. xx, p. 305) these methods have undergone numerous modifications, and several are employed at the present time. All, however, are variants of the two main types: (1) *Unilateral exclusion*, in which the delivering segment is interrupted in its continuity immediately beyond the seat of the anastomosis; (2) *Bilateral exclusion*, the original method of Salzer, in which the bowel is divided a second time at the distal extremity of the excluded segment.

Pure bilateral exclusion has been shown to be an undesirable procedure, since the collection of intestinal secretions, of gas, and in some cases the accumulation of the products of ulceration of the wall of the excluded segment of bowel, give rise to the formation of a sac from the interior of which systemic auto-intoxication and infection take place, and which, by bursting, may give rise to local disaster.

To obviate these defects various methods have been devised: (1) A unilateral exclusion is performed, and the proximal end of the excluded segment is drained by its implantation into the colon beyond the point at which the anastomosis has been established (Monprofit) (see Fig. 218). (2) The distal end of the excluded segment may be brought up to a special opening in the abdominal wall. (3) To the last arrangement may be added the establishment of a small safety vent near the proximal end of the excluded segment. (4) In a cruder method, that of Hochenegg, the two open ends of the excluded segment are brought to the surface at special openings made in the abdominal wall for their reception

away from the original operation wound (see Fig. 219). This method is convenient in cases in which it is desired to treat the interior of the excluded segment with medicaments, and it has been found by experience that only the distal opening remains of any material size, the normal peristalsis directing the discharge of contained matter in the habitual direction.

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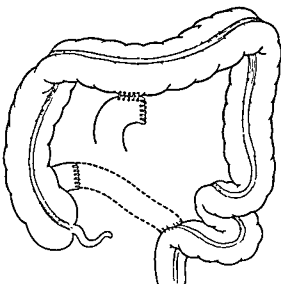


Fig. 218. Method of Monprofit. The proximal end of the ileum has been anastomosed to the transverse colon. The dotted line shows the distal end of the ileum implanted at the upper end of the pelvic colon. (*Modified from Hartmann.*)

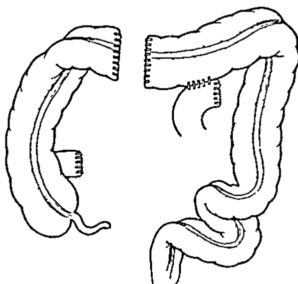


Fig. 219. Bilateral Exclusion. Ends of the excluded segment closed. The ends may be treated in other manners. (1) They may be brought up and sutured into separate special openings made in the abdominal wall. (2) A vent may be established in the cæcum, or by an appendicostomy, and the distal end of the excluded segment brought to the surface. (*Modified from Hartmann.*)

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Indications for unilateral exclusion. The operation may take the place of simple lateral anastomosis in chronic obstructions of the bowel unsuitable for radical measures. In the case of malignant growths, however, experience has not shown that any better results are attained (Hartmann, *loc. cit.*, p. 88), while it is probable that the products of degeneration, should the growth be breaking down, are the more likely to be passed steadily onwards the less the peristalsis is interfered with. As far as the other indications set forth for simple lateral anastomosis are concerned, it is evident that unilateral exclusion should not be performed when the result required is only a temporary one.

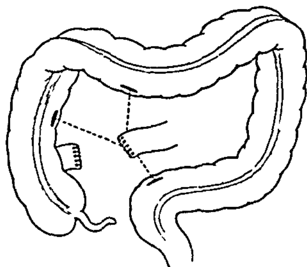


FIG. 220. UNILATERAL EXCLUSION. Ileum divided. Both ends closed. The dotted lines indicate some of the positions in which an anastomosis may be established. A proximal vent may be established in the cæcum or by appendicostomy if desired.

The operation is more frequently indicated in the following conditions:—

1. *Pyo-stercoral fistulæ*, such as may be met with after attacks of gangrenous appendicitis. In these cases local operations generally fail from the same cause that has prevented the closure of the fistula, namely, the presence of continued suppuration. The plastic closure of the opening in the bowel nearly certainly gives way with the advent of suppuration in the abdominal wall, while the necessity of providing drainage in such cases still further prejudices the probability of success. On the other hand, a simple lateral anastomosis is insufficient to completely divert the passage of the fæces from their normal course.

2. *Pyo-stercoral fistulæ consequent on tuberculous disease*, unsuitable for treatment by more radical measures. In tuberculous disease beyond the question of removing the inconvenience of the fistula; the diversion of the fæces from the diseased portion of the bowel, and the possibility of the local application of medicaments by means of either the fistulous opening itself, or a more efficient supplemental vent, may allow a rapid improvement in the primary diseased area.

3. *Fistulous communications* between the bowel and other abdominal or pelvic viscera. Hartmann has successfully treated a vagino-intestinal fistula by bilateral exclusion of the affected segment of small bowel. The

two ends of the excluded portion were sunk, since a vent for their contents existed in the presence of the vaginal fistulæ, and it was observed that the vaginal discharge rapidly diminished in amount, and eventually ceased, the unused intestine no doubt rapidly contracting and atrophying.

4. The method has been employed in various forms of colitis *as a substitute for colostomy*. Its application for such cases can only be a very limited one, since for the slighter cases of membranous colitis or dysenteric ulceration the measure is too grave, while in the presence of severe ulceration the possibility of reflux into the excluded portion of the bowel contra-indicates its use; again, the lower portion of the large intestine is rarely itself free from ulceration. Moreover, if employed, a vent (possibly an appendicostomy, which it must be allowed is a far less serious inconvenience than a colostomy) is necessary in order to prevent accumulation of gas and fæces, and to allow of local applications being made.

5. Unilateral exclusion has been somewhat largely resorted to in cases of chronic constipation, especially by Arbuthnot Lane (*Brit. Med. Journ.* 1908, vol. i, p. 126). The experience gained by this operation has been to emphasize the occurrence of distension in the excluded segment, and although troublesome symptoms from this cause are not constant, they have been sufficiently frequent to lead Lane to recommend a secondary removal of the excluded colon in a large majority of cases.

That the exclusion of the colon by an ileo-sigmoidostomy is not incompatible with fair body nutrition, and may even result in a large gain in subjects who have long suffered from the effects of auto-intoxication from the colon, has been abundantly proved by the operation of Arbuthnot Lane, and in a lesser degree by the observation of patients in whom the same operation has been performed for the relief of obstruction from malignant disease. Moreover, it has been proved that trouble arising from the fluid nature of the intestinal contents delivered into the sigmoid flexure of the rectum is very shortly got over. That the latter should be the case is no cause for surprise, when the experience of a similar solidification of the fæces is observed in colostomies performed in the cæcum, even if the conditions for the absorption of fluid are not equally good. In this relation the free absorption of saline fluid introduced into the lower bowel, and the rapid gain in consistency of a diarrhœic motion, if retained for a time in the rectum, may be instanced to show that the reputed special capability of the cæcum to absorb the unnecessary fluid component of the fæces may be more an accident of position than due to any special character possessed by that portion of the colon.

E. W. Hey Groves and J. Walker Hall have reported on the analysis

of the excreta in two cases in which portions of the colon had been excluded by operation (*Lancet*, 1909, vol. i, p. 236).

The results in the first case showed: (1) 'that the amount of absorption of water was abundant, the diarrhœa being due simply to the discharge of mucus; (2) that the amount of nitrogen and fat in the fæces, although high in proportion to the intake, represented the almost irreducible minimum that was always present in the fæces.'

In the second case, an ileo-sigmoidostomy in a youth of nineteen, where the bowels acted regularly once daily, 'that water absorption was amply carried on by the pelvic colon and rectum, and that while the absorption was not quite so good after the colon had been removed, it was quite sufficient for the nutritive economy.'

When, however, these points are conceded, it appears doubtful whether the operation should be often performed for simple constipation, in view of the facts that a secondary removal of the colon is often required, and that, in spite even of these radical procedures, purgative medicines may still be necessary to ensure the action of the bowels. The results of ileo-sigmoidostomy have indeed only afforded another illustration of the difficulty of dealing with chronic constipation due to inefficient action of the intestinal muscle by any surgical method.

6. In some instances, where an enterectomy has been performed, approximation of the remaining bowel ends may be extremely difficult or impossible. Under these circumstances it may be desirable to perform an ileo-sigmoidostomy, and fix either the distal end of the excluded segment into an opening in the abdominal wall, or the two ends of the bowel may be brought up to the surface at separate openings by Hochenegg's method.

Operation. The first stages in the performance of a unilateral exclusion differ in no way from those necessary for the establishment of a lateral anastomosis, the only addition consisting of the division of the proximal element of the junction immediately beyond the anastomotic opening.

The division may be accomplished by simple section of the bowel and closure of the ends by suture as already described on pp. 441–4. In this operation, however, the additional security obtained by the use of a crushing clamp, as advised by Kocher, Doyen, and others, is very great, since any actual opening of a patent intestinal lumen is avoided. The clamp may be applied prior to the establishment of the anastomosis, and left in position until the suturing of the junction is complete, by which method the complete adhesion of the compressed intestinal mucous membrane is assured; but really only a few minutes are necessary to attain this end.

Some of the various methods of intestinal exclusion are indicated in

Figs. 217-20, and no further description of detail seems necessary for their comprehension.

Prognosis and results. The establishment of an intestinal anastomosis is an operation in itself so simple, and it is so frequently performed on the bowel in a comparatively normal condition, that the results obtained might be expected to surpass those of most other opera-

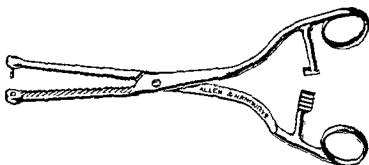


FIG. 221. KOCHER'S CRUSHING CLAMP.

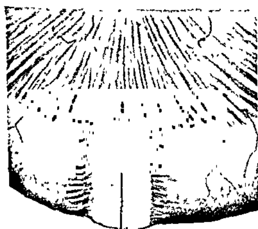


FIG. 222. ILEUM CRUSHED BY A CLAMP (ENTEROTRIBE). A double width has been clamped to allow of convenient division.

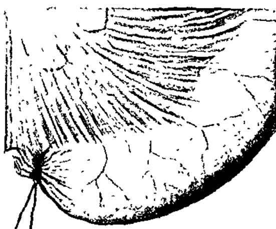


FIG. 223. END OF ILEUM CRUSHED AND LIGATURED PRIOR TO ITS INVERSION BY A LINE OF SUTURE.

tions on the intestinal canal. The rare occurrence of failure in obtaining good local union in gastro-intestinal anastomoses also supports this expectation. Lateral anastomoses and partial exclusion are, however, methods so commonly employed in patients whose general and local condition is in the last degree unsatisfactory, that we find the published statistics of the results of the operations far from good. The operations are naturally most successful when performed for non-malignant conditions, as in intestinal fistulæ, for some forms of intestinal obstruction, or somewhat less so in cases of tuberculous disease.

Of 21 anastomoses established in cases of carcinoma of the colon in St. Thomas's Hospital 7 (or 33·3 %) died, the average result approximating itself closely to that obtained after partial colectomy. Hartmann quotes 37 cases collected by De Bovis, with 9 deaths; 11 by Terrier, with 3 deaths; and 14 by himself, with 4 deaths (all colo-colostomies). Thus, 62 cases in all, with 16 deaths, a mortality of 25·9 %. Of 10 cases of ileo-sigmoid-ostomy for chronic constipation published by Arbuthnot Lane, in which further interference with the colon was not undertaken on account of the bad general condition of the patient, 2, or 20 %, died.

CHAPTER XI

OPERATIONS FOR FÆCAL FISTULÆ AND ARTIFICIAL ANUS

Fæcal fistulæ may be congenital, and then usually consist in the external orifice of a patent vestigial vitello-intestinal duct. The operative treatment under these circumstances does not differ from that described in the section relating to Meckel's diverticulum, except in so far as a preliminary closure of the opening by suture is needed prior to the removal of the diverticulum. This operation should not be undertaken at too tender an age.

Acquired fæcal fistulæ may result from injury, the sloughing of strangulated portions of the bowel, sloughing of the bowel-wall due to gangrenous cellulitis, or the perforation of simple stercoral ulcers. Certain diseases of the intestine, such as tubercle, actinomycosis, and carcinoma, may also be accompanied by the formation of fæcal fistulæ, usually secondarily to the development of an abscess. More rarely, disease of neighbouring structures, *e. g.* tuberculous disease of the bone or disease of other abdominal viscera, may give rise to the formation of an abscess, which by opening spontaneously both into the bowel and on to the surface of the body, results in the development of a fæcal fistula.

For purposes of treatment fæcal fistulæ must be divided into two classes. (1) the purely stercoral, and (2) the pyo-stercoral.

OPERATIONS FOR STERCORAL FISTULÆ

In the least important variety, such as is seen after appendicitis operations or suppurations, and sometimes in herniæ where the gangrene has been of a limited character, the track of the fistula is of some length, and no fusion of the skin and mucous membrane takes place. The track of the fistula is then lined by ordinary granulation-tissue, and spontaneous closure is the rule if sufficient patience be exhibited in the treatment.

Operation. When such fistulæ are short, and open directly upon the surface, healing may sometimes be aided by the formation of a small skin flap which is slid over the opening and fastened in such a manner as to allow free vent to the discharge at the margins. The valvular exit and obliquity in the course of the track thus attained will aid spontaneous

closure. This method is well worthy of trial in small fistulæ with slight amount of discharge, when a more extensive procedure is not advisable.

When the fistula is of more important dimensions and fusion of skin and mucous membrane has taken place at its mouth, a more thorough operation is required.

The preliminary preparation of the patient for any of these procedures is of the first importance for their success. Care should be taken, by the previous administration for some days of intestinal antiseptics such as salol (gr. 5–10 t. d. s.), or a culture of lactic acid producing organisms, that the intestinal canal be as aseptic as practicable; a purgative should be administered thirty-six hours previous to the time of operation, and the bowel should be well washed out locally some five hours before the patient comes to the table.

If the small intestine is to be dealt with, and there is reason to suppose that the distal segment of the bowel is contracted, it is well to attempt to dilate this by the passage of bougies for a few days. In the case of the large intestine, a Mitchell Banks's tube may be inserted with the same object. If an ascending or transverse colostomy opening is to be closed, the administration of large enemata by the natural anus, to dilate the lower colon, may help to increase the calibre of the contracted bowel and prepare it for the resumption of its normal function.

Lastly, the preparation of the skin of the field of operation is a matter of much importance and difficulty. When the fistula is connected with the small intestine, or the cæcum, the power of digestion possessed by the fluid intestinal contents needs to be combated. This may be attempted mechanically by the application of a fenestrated rubber apron, fixed at the margin of the opening by rubber solution. Again, the introduction of a tube may allow the greater portion of the escaping fluid to be diverted from contact with the surface. The other mode of protection is by the application of ointments. Hard paraffin ointment, which is liquefied by heat and applied with a brush, sometimes serves well, but it has a tendency to crack off and expose the skin in lines. If this be so, a softer ointment must be thickly applied. In spite of all endeavours, however, the operation has often to be performed in the presence of an unsatisfactory condition of the skin, and in this case the employment of an apron fixed to the margin of the incision is desirable during the performance of the operation.

The first step, after a thorough cleansing of the surrounding integument and the bowel in the immediate neighbourhood, is to make an encircling incision of the skin about a tenth of an inch from the margin of the fistula. The opening is then closed by a continuous suture, the ends of which are left long to give the surgeon control of the bowel.

A longitudinal incision is carried from either end of the oval defect, and by means of this the tissues of the abdominal wall are carefully dissected away from the central neck enclosing the fistula. For this purpose the incision is first deepened from either end, until the parietal peritoneum is reached, and the dissection is then carried up to the neck of the fistula.

The further procedure varies with the size of the opening, and the amount of tissue enclosed in the neck. If these be small, a purse-string suture may be passed around them, tied, and the projecting neck cut away. If larger, a controlling suture should be passed at either extremity of the closed opening in the bowel, the bowel and peritoneum are drawn forward, and the wound is protected by gauze. The projecting neck is then cut away, and a continuous through and through suture is rapidly passed to close the defect in the bowel-wall.

The closed opening is now sunk by a second line of suture passed through both parietal peritoneum and the bowel wall-itself. In the small bowel the line of suture should be transverse to the long axis of the bowel; in the large intestine the direction of the line of suture is a matter of little moment.

The above operation (Grieg Smith) aims at not opening the peritoneal cavity. In many cases, however, this aim is frustrated by accidental injury to the peritoneum during the process of freeing the neck, and generally the introduction of the second line of suture may be much more efficiently performed if the peritoneal coat of the bowel is exposed. If therefore the earlier stages of the operation have been carried out without the escape of fæcal matter, it is preferable, after the first line of suture has closed the opening, to bring the bowel forward from the peritoneal cavity, if necessary freeing adhesions, insert some protecting gauze, and complete the suture with the bowel freely exposed. Not only does this plan allow of more satisfactory stitching, but it also avoids the necessity of leaving the bowel firmly anchored to the abdominal wall.

The opening in the bowel having been closed, the defect in the peritoneum is repaired, the muscular layers of the abdominal wall are reunited by means of catgut sutures, and the skin wound is sutured with silkwormgut.

OPERATIONS FOR PYO-STERCORAL FISTULÆ

These fistulæ are unsuitable to the mode of treatment last described, since the presence of suppuration introduces a new and greater element of risk to the peritoneal cavity; while union of the external wound cannot be hoped for unless drainage is provided, which latter seriously prejudices the success of the whole undertaking. Such fistulæ, moreover,

are often multiple, and the result of tuberculous or other forms of disease, in which more radical treatment is desirable.

As a rule, then, in pyo-stercoral fistulæ one of the forms of exclusion is indicated (see p. 478), and this may require to be supplemented by local treatment of the original focus of disease.

Of a somewhat similar character are the long tortuous fistulæ travelling between coils of intestine, such as may pass from the surface deeply into the pelvis in cases of tubal or ovarian suppuration, in which the intestine has been implicated. The greatest patience is necessary in dealing with these. The exposure of the opening in the bowel is difficult, and entails great risk of the diffusion of infection with whatever care the general abdominal contents are plugged away, while when exposed, the opening may be in a part of the bowel so fixed by adhesion to surrounding parts and so deeply placed, that suture is impracticable. As a general rule, therefore, the treatment of such fistulæ should be confined to providing a free passage for escape of the intestinal contents and promoting the formation of granulations.

OPERATIONS FOR ARTIFICIAL ANUS

This condition, in which the great majority of the entire mass of fæces is passed by the adventitious opening, is usually the result of surgical procedures, although it occasionally follows extensive sloughing of the bowel in herniæ, or as a result of gangrenous cellulitis.

Operation. The methods available for the closure of an enterostomy opening differ with the form of operation which has been primarily employed. In many cases in which a temporary vent only has been required, the lateral wall alone has been involved. Such openings possess rather the character of a fæcal fistula, than those of an artificial anus, and the treatment of them differs merely in degree from that already described.

When the whole calibre of the bowel has been involved, either by excision or loss of substance from sloughing, an additional obstacle to closure is offered by the 'spur' furnished by the projection of the mesenteric border. When the spur is of moderate dimensions, especially in the large intestine, its prominence may be gradually lessened by the method of Mitchell Banks. To the centre of a piece of large rubber tubing some 4 inches in length a strong string is attached. The tube thus provided is inserted into the distal segment of the bowel through the artificial anus, and passed downwards until entirely within the external opening. By means of forceps and the controlling string the tube is now drawn upwards into the proximal limb of the bowel until the string is in the centre of the opening. Lastly, the string is tied around a pad, or a second

piece of tubing laid on the abdominal wall across the anus, and parallel with the course of the bowel beneath. In some cases the tube is with difficulty retained; in others it may be kept in position for days and the whole intestinal contents diverted into their proper channel. This method is extremely useful as a test of the capability of the bowel to resume its function, when the closure of a temporary artificial anus for such diseases as ulcerative colitis is contemplated.

Should this preliminary measure prove successful, not only will the projection of the spur be lessened, but the adventitious anus will also decrease in size, and a simple plastic operation may suffice.

In more complete cases the method of closure differs in the case of the small and large intestine.

In the small intestine, if the diversion has been complete, and any considerable time has elapsed since the anus was established, a great

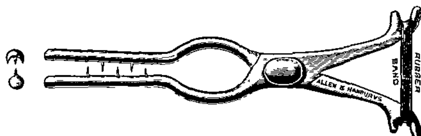


FIG. 224. VON MIKULICZ'S KENTOTRIBE.

incongruence usually develops between the upper and lower limbs of the bowel. Hence, not only is an enterectomy needed, but a considerable portion of the lower segment may require to be resected. (For methods of meeting the difficulties of incongruence in size, see p. 434.) Resection of the ends and a typical axial union is the preferable method in all such cases.

A type enterectomy is less often desirable in the large intestine, since the dangers of the procedure from the possibilities of operative infection are greater, while the persistence of a fæcal fistula in the event of incomplete success is a matter of far less importance.

Two methods of overcoming the difficulty dependent upon the existence of the 'spur' are available: (1) destruction of the spur by pressure with an instrument of the nature of Dupuytren's enterotome, or von Mikulicz's kentotribe; (2) the establishment of a lateral anastomosis at a distance from the artificial anus, which latter is closed by one of the plastic methods employed in fæcal fistulæ.

Of these methods the latter is the more rapid, and on that account often preferable. The former involves a considerable expenditure of time, but in the hands of von Mikulicz has proved itself remarkably safe.

When it is desired to establish a lateral anastomosis as a preliminary

to a plastic operation for the closure of the artificial anus, the only special details to be taken into account are the cleansing of the skin and the exclusion of the anus from the field of operation by plugging both limbs of the bowel, and by careful sealing with collodion during the performance of the operation.

When it is intended to employ an enterotome, the method of von Mikulicz is the best. At the time of the primary operation the two limbs of the bowel are sutured side by side for some 3 or 4 inches, in order to ensure their parallel arrangement and a certain degree of adhesion prior to the application of the enterotome. The enterotome (kentotribe) exerts its pressure by means of an elastic band applied round the handles. The pressure is moderate, thus 6–8 days elapse before the instrument separates, instead of the 3–4 necessary when the enterotome of Dupuytren is employed. Only ¾–1 inch of the tissues are included at a time, and the projecting margin of the spur is left to the last and then destroyed by the application of an elastic ligature. The determination of when a sufficient amount of spur has been destroyed to ensure a free passage is made by digital examination, and when this has been effected the anus is closed by a plastic operation.

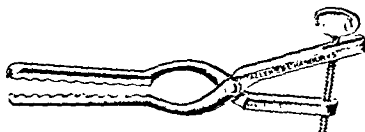


FIG. 225. DUPUYTREN'S ENTEROTOME.

F. Krauss has modified the kentotribe of Mikulicz, in such a manner that only the deeper part of the spur is perforated. Thus, a lateral anastomosis is established from within the bowel, and the external opening is then closed as in the other procedures.

The treatment of the intestino-vesical and intestino-vaginal fistulæ is referred to under the headings of colostomy (p. 408) and lateral anastomosis and exclusion (p. 478) It is rare that such conditions are suitable for direct treatment unless due to simple inflammatory disease. Fistulous communications between neighbouring coils of intestine, as for instance between jejunum and rectum, may occasionally demand treatment, and for such an abdominal exploration is the only resort. The adhering portions of intestine may be able to be separated and the openings closed by suture. If this prove impossible, as in the case of disease of the intestine, the small bowel must be clamped and divided above and below the opening, and an axial union effected between the extremities. The two ends of the portion of small bowel communicating with the large are then closed, and a total exclusion is made.

Prognosis and results. The minor operations for the closure of fæcal fistulæ entail little danger when carefully performed. The operations for the closure of an artificial anus are more serious, but the gravity in great part depends upon the nature of the cases for which they are needed.

Resection of the small bowel for artificial anus has been followed by good results. As long ago as 1885, when the writer, on the occasion of performing the first successful resection of the small intestine in this country, collected some Continental results (*St. Thomas's Hosp. Rep.*, vol. xiii, p. 181), the mortality was shown to be 38·4%, but it is now far lower.

Resections of the large intestine have been less favourable, but the results of short-circuiting and the use of the enterotome have been good. The closure of an artificial anus made for the treatment of ulcerative colitis is especially attended with risk (see p. 407).

CHAPTER XII

OPERATIONS UPON THE VERMIFORM APPENDIX

APPENDICECTOMY

INDICATIONS FOR THE OPERATION

(i) **Acute appendicitis.** Acute inflammation of the appendix, the most important indication, is often the most difficult to insist upon, since the surgeon has not always a free hand. It is necessary, therefore, to discriminate between cases in which an operation is indispensable and those in which it is merely expedient or justifiable. Thus, while the removal of an appendix in a condition of acute catarrhal inflammation may be fully justified, yet in the large majority of instances it cannot be said to be absolutely necessary; while, on the other hand, certain conditions, such as acute gangrene or gross perforation, demand immediate operation if a fatal issue, widespread infection, or the undesirable complication of an abscess is to be avoided. The general tendency of increasing experience is towards early operations in all instances in which the signs are of gravity; by this course the stage of reactionary peritoneal inflammation is often caught prior to any serious infection, and the operation can be completed without the necessity of providing drainage in even severe cases of local or general gangrene.

If the general symptoms are not severe, accompanied by no rise of temperature or by a rise lasting not more than thirty-six hours, if the pulse does not exceed 80–90 with no tendency to rise, and the local signs are slight, there is no necessity to press an operation, but even in such cases, if there be any reason to conclude that an appendicectomy will eventually be needed, postponement of an operation only means loss of time and consequent disadvantage to the patient.

The following symptoms and signs afford the most important indications for operation :—

Severe pain, especially when recurrent; rise of temperature; a rapidly rising pulse, accompanied by increased frequency of respiration; vomiting; urgent diarrhœa when present; painful or difficult micturition; restlessness and insomnia; local immobility of the abdominal wall; local rigidity; local tenderness; local induration.

Of the whole complex, pain, sleeplessness, rapid pulse, and sharply localized extreme tenderness are the most valuable.

Time at which to operate. Operations for acute appendicitis may require to be undertaken in three definite stages of the disease.

1. *Early.* These operations are performed during the first twenty-four to forty-eight hours after the commencement of the disease. In such the formidable complications due to severe or extensive peritoneal infection are rarely met with, and the 'early operation' is one of the most successful and satisfactory in abdominal surgery.

2. *Intermediate.* Operations in this stage are designated 'operations of necessity'. They are performed on from the third to the sixth day, and form the most dangerous and least satisfactory class of the whole series. General or very extensive peritoneal infection or severe local spreading infection is the condition which commonly needs to be dealt with. The indications for operation have often supervened upon the so-called 'latent period', and the experience of such cases has done more to popularize the 'early operation' than any records of success in the performance of the early operation itself.

3. *Late.* Operations performed from the sixth day onwards. These are usually demanded by the occurrence of symptoms indicating a slow spreading infection, or when severe symptoms indicate that a secondary extension has spread from a previously localized infection. Their seriousness places them between the early and intermediate operations in gravity.

(ii) **Recurring appendicitis.** Since the early advocacy of appendicectomy for this condition by Treves, this indication has been the one most commonly acted upon. Such operations, commonly spoken of as 'interval operations', can be performed with little risk to the patient, are often very easy of accomplishment, and, it must be owned, have been practised with a greater degree of frequency than necessity warrants. It is of much importance that the operation should not be performed in cases of uncomplicated mucous colitis or enterospasm, since such operations are responsible for the greater number of the failures to relieve existing symptoms, and bring the procedure into discredit.

Indications. Certain questions need to be considered. First, is a single attack allowed to pass from the acute stage to be recognized as an indication? The affirmative answer to this depends on the degree of severity of the first attack, the accompaniment of the local signs by fever, the temporary development of swelling, or the persistence of a tender appendix, indicating peritoneal involvement. If none of these indications are present the patient may be allowed to take the risks of an expectant attitude on the part of the surgeon.

If a second attack occurs, even if slight, no doubt exists as to the advisability of an operation. The risks of any subsequent seizure are quite incalculable; thus, after numerous insignificant attacks, which have

not necessitated more than a day's rest in bed, a seizure of the most severe grade may ensue, and place the life of the patient in imminent risk. Again, the mere inconvenience attending the recurrent interruptions to health and occupation is in itself a strong indication for removal of the cause of the attacks, when the small risk to life or health involved in the operation is considered.

(iii) **Chronic appendicitis.** This is an important indication, only separable from the last on the ground that the symptoms of the disease, particularly those dependent on auto-intoxication, are more or less constant. In this condition, as in that of rapidly recurring attacks, the good effect of removal of the appendix is most striking.

(iv) **The previous occurrence of a local abscess.** The appendix can rarely be safely removed simultaneously with the incision and drainage of an abscess. Such a procedure necessitates an unduly extensive wound, the provision of very free drainage, and entails undesirable risks both from the point of view of the diffusion of infection, and of the danger of injury to the soft and lacerable intestine. Again, the stump can often be only very unsatisfactorily dealt with. A local abscess indicates a gross perforation of the wall of the appendix, which accident, unfortunate though it be for the peritoneal cavity, ensures the existence of the appendix much as an early spontaneous opening or incision saves a finger the seat of a whitlow. The significance of the appendical abscess as *an indication for subsequent appendicectomy has been much discussed.* It has been asserted that local suppuration protects from future attacks, the appendix being obliterated or destroyed. It is an undoubted fact that the gangrenous organ is occasionally met with in the abscess cavity, and in such instances a cure is assured, but in the immense majority of instances the perforation in the appendix heals, and future attacks are more probable than in cases where repeated attacks of a slighter nature unaccompanied by gross suppuration have been followed by cicatrization and destruction or atrophy of the organ (see p. 517). *With regard to the* difficulty of such operations it is remarkable, if some eight or ten weeks are allowed to elapse before proceeding to remove the appendix, how more or less completely peritoneal adhesions may have disappeared. The most frequent exception to this last statement is found with a retrocæcal position of the appendix; it must be allowed that in this instance very formidable difficulties may be met with, and for this reason the rectus-sheath incision (see p. 496) is to be preferred in dealing with such cases as affording greater possibilities of easy extension of the wound.

(v) **Abnormal conditions of the mesentery of the appendix.** The most common of these is the sharp bend in the appendix due either to a congenital peculiarity, or more frequently to mesenteritis, the result of

an intramesenteric perforation. In either case attacks of colic are common, and more serious inflammatory attacks due to retention of fæcal matter in the distal part of the organ are to be feared.

Occasionally an abnormally long mesentery allows a torsion or volvulus; this has been known to give rise to gangrene of the appendix, also to well-marked recurrent attacks of appendicitis. It is a definite indication for appendicectomy, but more often discovered by operation than diagnosed beforehand.

(vi) **The presence of a stercolith or foreign body in the appendix.**

(vii) **Appendicitis accompanying or complicating mucous colitis.** This indication is one of the most difficult to lay down with precision.

In some instances mucous colitis is undoubtedly secondary to appendicitis, and in such appendicectomy suffices to bring about a cure, especially if followed by careful after-supervision as to diet and regulation of the bowels.

In others the signs of appendicitis are only a part of those of a general colitis, and removal of the appendix at the most affords but a temporary relief from the symptoms.

The discrimination of the two conditions is one of great difficulty, while the discredit which obtains to errors in the choice of cases for operation renders the greatest care necessary.

Speaking generally, the free passage of mucus in the stools is a definite contra-indication to the performance of appendicectomy, except in the presence of gross local signs of disease of the organ.

(viii) **Malignant disease of the appendix.** The actual frequency of this condition is a matter of some uncertainty, since it has been discovered only as a result of operation or post-mortem examination. Rolleston and Jones (*Trans. Med. & Chir. Soc.*, 1906, vol. lxxxix, p. 125) have collected 33 instances in which primary malignant disease was found in appendices removed during life; 4 of these operations were undertaken for the relief of symptoms referable to the female pelvic viscera, 2 in consequence of the existence of fistulæ, and 27 for symptoms pointing to appendicitis in one form or another. As an indication for operation, the uncertainty or impossibility of diagnosis robs the condition of much importance. The growths are usually carcinomata, but cases of sarcoma and endothelioma have been reported.

(ix) **Tuberculous disease.** This is not often localized to the appendix, and removal of the latter has not been attended by very gratifying results. In connexion with the operation the beneficial effect of the mere opening of the abdomen for tuberculous conditions is to be borne in mind. Should advanced tuberculous disease of other organs exist, the operation of appendicectomy is contra-indicated, since tuberculous

disease of the appendix is rarely followed by the acute complications common in the pyogenic infections.

(x) **Actinomycosis.** It is uncommon for actinomycotic infections to be discovered until the cæcum or surrounding parts have become invaded by the disease; hence the disease is rarely to be regarded as an indication for a simple appendicectomy.

METHODS OF OPERATION

The incision. One of two methods of incision of the abdominal wall suffices for the removal of the appendix in most cases.

McBurney's incision. This method is the most suitable for interval operations where there is no reason to suspect any unusual difficulty in the removal of the appendix. The incision gives good access to the field of operation, hence is greatly superior to the small opening by division of muscle where the whole process of detection and separation of the appendix needs to be accomplished by aid of the sense of touch and out of the sight of the surgeon. The resulting cicatrix is also stronger and less likely to form the seat of a ventral hernia.

An oblique incision about 3 inches in length, but varying with the size or degree of obesity of the patient, is made, commencing about 1 inch above a line drawn from the umbilicus to the anterior superior iliac spine, and crossing the line about 1½ inches from the latter process, and is carried through the skin and subcutaneous fat. A small vessel usually needs to be secured at the upper angle of the wound, and at the lower end the superficial epigastric vessels may be divided (see Fig. 226).

The fibres of the aponeurosis of the exposed external oblique muscle are separated by an incision running parallel to their course, and the fibres of the internal oblique muscle are exposed running in a direction at right angles with those of the overlying aponeurosis. By the aid of a retractor and blunt dissector the fibres of the muscle at one of the more obvious intersections are separated (that containing the cutaneous branch of the ilio-inguinal should be avoided) and drawn apart, exposing those of the transversalis and a portion of the anterior aponeurosis of that muscle. The fibres of the transversalis are similarly drawn apart, and the transversalis fascia exposed. Traction by a pair of retractors may now be employed to obtain a sufficiently wide opening. Some small branches of the deep circumflex iliac artery may be torn and need to be secured, but hæmorrhage is minimal.

If a pair of slightly hooked retractors be employed, as in Fig. 226, the floor of the wound may be raised by an assistant, the transversalis fascia divided in the line of the external incision, and the peritoneum carefully opened and incised to a corresponding extent. The two edges

of the cut peritoneum being secured with pairs of artery forceps, the field of operation is now freely exposed.

If during the subsequent stages of the operation the space provided by McBurney's incision should prove insufficient, it may be increased by division of the anterior aponeurosis of the transversalis carried onwards into the sheath of the rectus muscle. In prolonging the incision the fibres of the rectus may be displaced inwards, and the opening continued nearly to the middle line, care being taken to spare the deep epigastric vessels, if possible, by displacing them with the muscle.

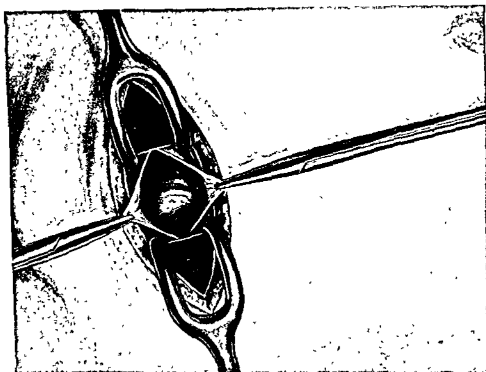


FIG. 226. McBURNEY'S INCISION. The divided aponeurosis of the external oblique muscle is indicated by the white line. Retractors control the separated margins of the internal oblique and transversalis muscles. The peritoneal margins are held in forceps.

The rectus-sheath incision. This incision is suited to all appendicectomy operations, but is more especially useful in cases where abundant space may be needed, and where subsequent drainage of the abdomen may be necessary. In both instances it is of proved utility, since it is readily prolonged upwards when more room is needed for manipulation or exploration, while if circumstances (such as the unexpected discovery that the inflammation is secondary to the disease of the female pelvic organs) should arise, the incision can be prolonged downwards to give free access to the pelvis. The obliquity of the wound cleft allows the

retention of drainage tubes for a week or more without risking the eventual development of a ventral hernia. McBurney's incision, on the other hand, is very unsuitable for cases in which a drainage tube is needed, since it is often inadequate and a direct opening is always left where peritoneum and skin eventually come into more or less close contact. It is also inconvenient if free access to the pelvis should prove necessary. The rectus-sheath incision has the disadvantages of not being so directly situated over the root of the appendix, hence some greater degree of traction on the outer margin of the wound may be needed, the area of the abdomen occupied by the small intestine is more widely encroached upon, and a part of the nerve-supply of the rectus is endangered. These minor defects are, however, to be met by care, and are more than fully counterbalanced in suitable cases by the advantages of the incision set forth above.

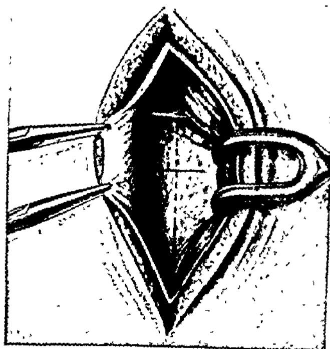


FIG. 227. RECTUS-SHEATH INCISION. The rectus sheath has been opened, and the muscle and epigastric vessels retracted inwards The posterior layer of the rectus sheath remains undivided. The dotted line indicates the ordinary incision, the firm line the direction of the transverse

As originally devised by Battle, the incision through the skin and subcutaneous tissue is an oblique one, about 4 inches in length. The centre of the incision bisects at right angles the line from the umbilicus to the anterior superior iliac spine at its mid-point, and it lies within the right linea semilunaris.

A vertical incision over the outer third of the rectus of the same length, and commencing below the level of the umbilicus, serves equally well. Some small subcutaneous vessels only need to be taken up with artery forceps (see Fig. 227).

The sheath of the rectus is divided for the whole length of the wound,

this structure being arranged in two distinct layers in at least the lower two-thirds of the wound. The outer margin of the rectus muscle is exposed by a few touches of the knife, the open sheath drawn outwards, the margin of the muscle freed and drawn inwards, the deep epigastric artery being freed if necessary and retracted together with the muscle. One transverse arterial branch usually needs division, and two branches of the twelfth intercostal nerve are met with. The lower nerve, a small one, is usually divided; the upper larger branch must be preserved if possible.

The exposed posterior layer of the sheath, the fascia transversalis, and the peritoneum are successively incised vertically, and the abdomen opened.

The outer margin of the wound is now freely retracted, and, after necessary exploration, the area of operation is limited by the introduction of protecting plugs as in the other incision.

When no great amount of space is required the incision of the posterior layer of the rectus sheath may be made transversely so as to avoid risk to the nerves to the rectus muscle, but this method compromises one of the chief merits of the incision, *viz.* the capacity for prolongation and consequent free access to the abdominal cavity.

THE OPERATION IN QUIESCENT INTERVALS

McBurney's incision is generally preferable. The abdomen being opened, search for the appendix is made. The portion of bowel exposed by the incision is usually the ascending colon, 2 or 3 inches above the cæcum. When previous attacks of appendicitis have been accompanied by peritoneal inflammation, adhesions often exist between this portion of the colon and the anterior abdominal wall. Due care must be observed in the separation of these, and the possibility of their existence must be borne in mind in the preliminary incision of the peritoneum. The existence of permanent adhesions in this position is of interest as indicating the increased disposition to their formation when a fixed portion of bowel is concerned, since the more mobile cæcum is rarely adherent anteriorly, although often fixed deeply by occlusion of the fold of peritoneum passing from its deep aspect to the iliac fossa.

The appendix when enlarged, or if free, is generally readily detected on palpation; if free, it may be at once drawn up into the wound; if adherent, it may often be easily freed by careful manipulation with the finger; when this is not the case, dissection may be needed.

The appendix discovered, and if possible delivered together with the free end of the cæcum, plugs are introduced downwards to the entry into the pelvis, inwards to protect the small intestine, upwards on the

surface of the colon, and into the groove between the outer wall of the colon and the abdominal wall. The ends of these plugs, where brought out, protect the external wound. In this way all chance of internal dissemination of infection is avoided; a piece of gauze is placed over the exposed cæcum, and the removal of the appendix is proceeded with.

When difficulty arises in the detection of the appendix, search is made on the following lines. The anterior longitudinal band on the surface of the cæcum is followed to its commencement, which procedure gives a rough indication of the position of the base.

Attention is then given to the more common positions.

1. *The appendix may project forwards.* In these instances the distal portion is usually sharply bent, and this and the tip are often surrounded by adherent omentum. The combined mass is usually readily detected on digital exploration (indeed a previous conclusion as to this position may have been made from external examination), but the mass is usually held out of sight to the inner side of the wound by adhesions to the anterior abdominal wall which require to be separated.

2. *The appendix may lie at the pelvic brim*, often then closely associated with the under surface of the mesentery; or it may lie deeply in the pelvis, commonly adherent to the pelvic wall, less frequently to the bladder in either sex, while in the female it may be intimately connected with the uterine appendages.

3. *The appendix may be retrocæcal.* In this case it may possibly be palpable through the walls of the cæcum. The retrocæcal appendix is one of the most troublesome to remove, as very firm adhesions often exist between the posterior wall of the cæcum and the iliac fossa. When the latter are separated the base of the reflection of the peritoneum is generally broken, and the retrocolic subperitoneal space is opened up, and this may need to be extensively disturbed in the removal of the appendix if long. In such instances especial care is needed to avoid infection, and if there is reason to think this has occurred it is wise to provide drainage.

When the appendix lies to the outer side of the cæcum, trouble may also be met with. The position in itself is apt to indicate a long appendix, and in fact such is often found, the tip of the organ even extending as far upwards as the under surface of the liver. It is in these cases that the McBurney incision is least convenient, and may require considerable extension to allow of the necessary manipulations.

The freeing of an adherent appendix is usually much facilitated by delivery of the cæcum from the wound, and entrusting it to the hands of an assistant to be held up after carefully wrapping it in gauze.

Other difficulties in tracing the appendix. Other difficulties may arise from the condition of the tube itself. The ordinary bulbous appen-

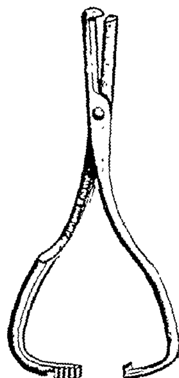
dix resulting from the retention of secretion or muco-pus beyond a stricture gives little trouble, except that needed to avoid the bursting of the structure during removal. In some instances the appendix may be practically divided, the distal portion having become atrophic instead of dilated, and this portion may be easily overlooked. In extreme instances of the latter condition the organ may be represented by its base and extreme tip only, the central portion forming a more or less tenuous cord. This cord, although with difficulty palpated by pressure against the abdominal wall, is generally to be traced as a band by traction on the cæcum. Such appendices are usually produced by repeated attacks of inflammation unaccompanied by suppuration. When the tip is attached to a neighbouring free viscus the band is a source of possible future intestinal obstruction; hence this reason for complete removal is to be remembered in addition to the possibility of the retention of secretion in the separated tip (see p. 538).

Difficulty in delivering the appendix more frequently depends on shortening and distortion of the meso-appendix than on surrounding adhesions. This condition is most common subsequently to attacks of appendicitis in the course of which perforation has occurred between the layers of the mesentery. In such cases a firm band of hard tissue usually gives rise to very firm fixation, and it must be remembered that the division of this tissue after at all recent attacks involves the laying open of infected tissues, and is consequently a cause of risk which may raise the question of the necessity of drainage. When the characteristic yellow areas of infected tissue in a state of coagulation necrosis are met with, it is advisable to snip them carefully away, and possibly to apply an antiseptic to the area under supervision.

Surrounding adhesions having been separated, the mesentery of the appendix is divided. If the mesentery be of sufficient length a *single* ligature is drawn by an aneurysm needle or pair of artery forceps through an opening in the bloodless area found near the base of the appendix and tied. A small vessel at the junction of the cæcum, which is not included, may generally be clamped for the moment, and is eventually controlled by the purse-string suture employed in sinking the appendix. When the mesentery is short and rigid it is better divided in sections after the previous application of artery forceps, and two or three ligatures may be required. It is convenient to keep the ligatures long until all have been tied, as control is thus retained should the hæmorrhage be not completely stopped.

Although the usual and most satisfactory procedure is to free the appendix prior to its removal, yet in some instances the density and extent of the adhesions present render this difficult or impossible. Again,

the process may demand so free interference with the cæcum as to involve much risk of damage to the integrity or vitality of the organ, as well as opportunity for the spread of infection. Under these circumstances it is often preferable to define the base of the appendix, and after dividing it, to dissect or strip out the organ from its base. If this method be decided upon, it is convenient to insert two mattress sutures into the cæcal wall on either side of the base of the appendix, prior to its division and ligature. In this way a safe command of the divided base is retained when that depending on traction of the appendix itself is removed, and no difficulty occurs in drawing over a proper covering of cæcal wall to sink the stump. The separated appendix, the base of which has been secured by a clamp or a provisional ligature, is now held up and the dissection or separation commenced from the proximal end.


Fig. 228. Kocher's Appendix Clamp. *Corner's modification.*

When the appendix is embedded in adhesions of such density and extent that its safe separation appears impracticable, Kelly's method may be employed. The appendix is freed at its base, a longitudinal incision down to the internal muscular coat or submucosa is made over it, and the tube is stripped out of its bed by gentle traction and blunt dissection.

Removal of the appendix. Previous to this step, the cæcum, or exposed bowel, is covered with some layers of gauze. Much ingenuity has been expended on devices for the actual separation of the appendix from the cæcum, the main objects of all being the avoidance of immediate infection from the stump, and the provision of a firm cicatrix to cover it in.

The most satisfactory methods are those in which the lumen is obliterated previously to section of the appendix. This end may be obtained by employing a special crushing clamp such as Kocher's (see Fig. 228). If the clamp be used an artery forceps is applied to the distal part of the appendix to prevent any escape of contents when it is divided. The edge of the thin ribbon-like crushed portion exposed on the upper surface of the instrument is rubbed over with a probe dipped in pure carbolic acid, the excess removed with a dry sponge, the clamp removed, and the base of the crushed portion is ligatured.

A purse-string suture is inserted around the stump, and the latter sunk. When there is any difficulty in raising the cæcum, or if it be held

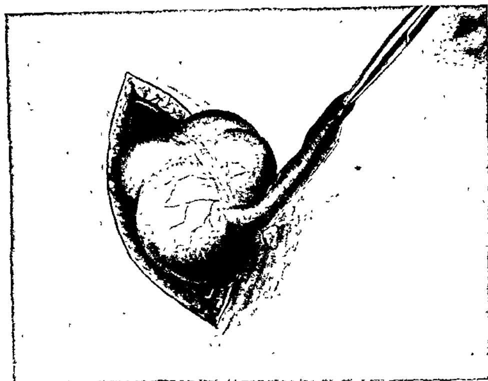


FIG. 229. THE CÆCUM DELIVERED. The appendix has been freed from its mesentery, which has been tied.

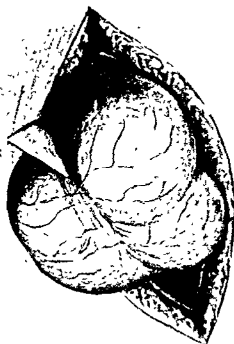


FIG. 230. THE APPENDIX REMOVED. The stump has been freed from the clamp.

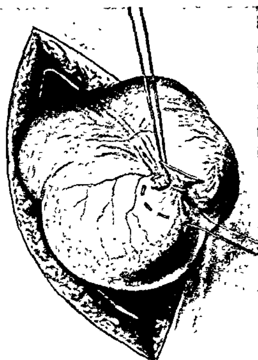


FIG. 231. THE APPENDIX STUMP LIGATURED, AND A PURSE-STRING SUTURE INTRODUCED.

forward with tension, it is desirable to insert either the purse-string or two mattress sutures prior to the separation of the appendix, and in this way trouble in introducing the sutures in the depth of the wound is avoided.

When the clamp is not preferred the same crushing method can be attained by the use of an ordinary pair of artery forceps. The best method consists in the application of three pairs side by side (Halsted). The middle pair is first removed, and the appendix divided in the groove between the two remaining ones. The distal clamp serves to prevent the escape of contents from the distal portion of the appendix.

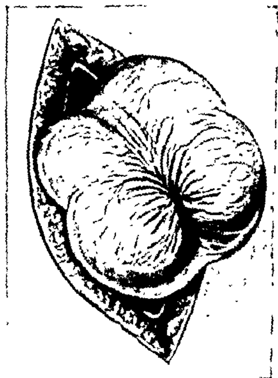


FIG. 232. THE APPENDIX SUNK, AND THE PURSE-STRING SUTURE TIGHTENED AND KNOTTED.

When the base of the appendix is inflamed and thickened by either acute or chronic disease, the crushing method is inapplicable, since the clamp is apt to cut through the tissues entirely, the infiltrated and brittle mucous membrane giving way together with the serous and muscular coats.

A flap method is then desirable, and the coat-sleeve circular amputation of Barker may be employed. The knife is carried by a series of light sweeps through the serous and muscular coats until the pale mucous membrane is exposed; with a blunt dissector, the cuff is separated and turned upwards, a ligature is applied to the mucous membrane, and, after the application of a retaining forceps on the distal side of the ligature, the appendix is removed

Some risk may arise in the removal of a so-called hydro-appendix, which may be a tightly distended sac, from the possible escape of fluid. Under these circumstances it is often better, after thoroughly protecting the subjacent area, to puncture the appendix and remove the fluid, when the remaining steps can be completed as before.

When the suturing of the stump is completed, the protecting plugs are removed and the closure of the wound is proceeded with. The peritoneum is closed with interrupted silk stitches. The separated muscle fibres are brought into position, and if necessary, which is rarely

the case, unless the type wound has been extended, secured by one or more loosely drawn catgut sutures. The external oblique aponeurosis needs three catgut sutures; these should be so passed as to draw the upper margin slightly over the anterior surface of the lower in order to ensure a firm union. With this object the needle, after piercing the upper segment, is entered on the surface of the lower segment and brought out in the same manner as in introducing a Lembert's suture in the intestine. The closure of the wound is now completed by the introduction of a sufficient number of cutaneous stitches.

THE OPERATION IN ACUTE APPENDICITIS

In really 'early' intervention this procedure is not usually accompanied by the serious difficulties which may attend 'interval' operations, but the conditions met with in the intermediate and late stages vary considerably and great judgment is required in the treatment of individual cases. The rectus-sheath incision affords the most satisfactory access.

On opening the abdomen free fluid may at once escape, rarely clear, more often of a gruel-like character, or so-called sero-pus. This should be at once absorbed by dry gauze plugs, care being taken not to unnecessarily disturb the immediate region of the appendix, especially if the effusion is not offensive in odour, since during the first forty-eight hours this fluid may be mainly reactionary effusion, and not necessarily highly infective. Plugs to protect the main abdominal cavity are introduced, and the search for the appendix carried out on the same lines as has been described in the previous operation.

If no gross perforation has occurred, the appendix is usually readily brought to the surface, exhibiting signs of acute inflammation, sometimes covered with lymph.

Under these circumstances it is removed and dealt with as in the interval operation, but it is important to bear in mind that the walls of the appendix are often in such a condition as to render the use of the crushing clamp dangerous.

If a gross perforation has occurred the immediate neighbourhood is occupied by stinking pus, sometimes mingled with fæces or escaped stercoliths, and to a certain extent localized. Perforations vary in position. A frequent and happy direction is into the meso-appendix. Under these circumstances peritoneal infection is often very limited in extent. If the perforation be in a free portion, the tip or a bend in the organ is a common site. If the appendix be pelvic in position, widespread pelvic peritonitis is usually present; if retrocæcal or at the outer border of the cæcum, infection is less extensive, but more difficult to deal with. The pus is to be carefully sponged away, and then the appen-

dix is sought for and freed. This stage of the procedure may be fraught with much difficulty; the appendix may be very adherent, possibly as the result of both old and recent adhesions, while the organ itself is softened and frequently more or less broken at the site of the *perforation*. The separation must be accompanied with all due care, but it is often necessary to carry it out quickly, and the elaborate precautions employed in interval operations to avoid infection are unnecessary under the circumstances. If the cæcum be very adherent it is not advisable to try and fully deliver it, since this step entails risk to the bowel itself, and also that of opening up and infecting the loose tissue of the retrocolic space. If the base of the appendix cannot be readily brought up, controlling sutures should be passed into the cæcal wall, an attempt made to fashion a peritoneal flap from the peritoneal and muscular coats, the mucous coat ligatured, and the organ removed. The controlling sutures previously introduced into the cæcal wall may now be employed to sink the stump.

In some cases the condition of the appendix, or its situation, may be such that a simple ligature of its base *en masse* is the only practical alternative.

When the appendix is in a state of general necrosis from gangrenous cellulitis, its removal is often easy, since adhesions are slight or absent; the danger in such cases is the extension of the infective process to the wall of the cæcum, or even to the ileum.

The appendix having been removed, the area of operation is carefully cleansed; if bowel has been delivered this may be washed over with normal saline, but the interior of the abdomen is better treated with dry gauze plugs only. The difficulty at this stage of the operation increases with the area of the peritoneal cavity involved; when not more than a quarter is invaded, the whole manipulations are carried out from the primary incision; if the condition be one of widespread diffuse peritoneal infection, secondary incision of the left side of the abdomen is sometimes advisable, both for immediate convenience and for the purpose of future drainage.

The question of drainage must be decided on the conditions present. When the appendicitis is of the acute catarrhal type and the effusion sweet, no drainage is required. The same may be the case even in acute gangrene, if no gross perforation has occurred, and the operation is performed during the first twenty-four or thirty-six hours. More frequently wide infection has occurred, and then drainage must be provided by the introduction of tubes and plugs. It is generally advisable to introduce two tubes, one into the pelvis, and the second into the iliac fossa in the neighbourhood of the base of the appendix, a long plug being

introduced around and between the two tubes. Drainage by plugs alone is unsatisfactory, since when once removed they cannot be satisfactorily replaced. The removal of the plug should be commenced on the third day, or the whole may be drawn out at the same time, a smaller plug being reintroduced to ensure sufficient gaping of the external wound.

The arrangements for drainage having been completed, the external wound is closed to a sufficient degree not to interfere with the outlet of discharge, or if drainage has been unnecessary, the wound is closed in layers in the ordinary way, silk stitches being used for the peritoneum, catgut for the rectus sheath, and silkworm-gut for the skin.

COMPLICATIONS AND SEQUELÆ OF APPENDICECTOMY

The frequency of occurrence of complications after the operation of appendicectomy varies in accordance with the stage of the disease in which it has been undertaken. Thus, complications are rare after operations performed during the first forty-eight hours, and in those undertaken during a quiescent interval. They are numerous and serious in operations performed in the intermediate period, in consequence of the more serious conditions induced by the progress of the disease.

The operation may fail to give relief from the symptoms of general infection. This is usually the result of too late interference and offers little scope for further measures. The special want of resistance exhibited by some patients must also be credited to the operation in some cases.

If the abdomen has been closed, the wound must be reopened and free drainage established. Other measures to be considered are continuous rectal injections of saline; or when collapse occurs, intravenous infusion, as much as 2 or 3 pints being introduced.

Subcutaneous injection in the flanks of anti-colon bacillus serum may be tried. 30 cubic centimetres should be given as a first dose, followed by 20 cubic centimetres at the end of the first twenty-four hours. The writer believes that great benefit results from this method of treatment. In any case the injections are followed by fall in temperature, decrease of pulse rate, easier respiration, greater ease, and frequently sleep. Injections of 10 to 20 cubic centimetres may be given every other day. Observation has shown that the use of the serum appears to further the process of localization in addition to its effect on the general condition, and even in cases which do not recover it definitely retards the progress of the disease (Makins and Sargent, *Trans. Clin. Soc.*, 1907, vol. xl, p. 146).

Spreading suppuration. The operation may fail to arrest the tendency of the process to extend. In some instances the extension may lead to a rapidly fatal issue; in others the patient may only succumb

at the end of weeks, more rarely even months, after the operation. The treatment of this condition is identical with that of the last, the provision of secondary outlets for the suppuration being the main distinctive feature.

Infection and progressive suppuration and sloughing of the muscles of the abdominal wall. This distressing complication of operation in the acute stages is fortunately rare, but it may necessitate numerous incisions, and only terminate favourably after the destruction of large areas, even nearly half of the entire muscular element of the abdominal wall.

The formation of secondary abscesses after operations in the acute stages. The abscesses vary in degree of contiguity, the most common being, in relative order of frequency, pelvic, left iliac, right lumbar, subdiaphragmatic, subhepatic, and perisplenic. The position in each case is likely to be dependent on the original localization of the appendix. Early incision is indicated in either position.

More rarely, suppurations may be more distant; thus in the pleura or lung. Such may occur independently of subdiaphragmatic abscesses, and may be remote complications occurring weeks or months after the original operation.

In operations performed during quiescent intervals secondary suppuration is rare, the most important forms being the stitch abscess and suppuration of blood-clot in the abdominal wall.

In a small proportion of interval operations abscesses may form at the end of the first week in connexion with the appendix stump, the area of operation, or in connexion with a small residual abscess cavity which was disturbed during the operation. Such abscesses require the provision of a free outlet and the maintenance of a short period of drainage. Many so-called stitch suppurations are really of this nature.

Pylephlebitis and pyæmia.

Fæcal fistula. This sequela may result from various causes. (*a*) Insufficient closure of the appendix stump, often unavoidable where the latter is much thickened and inflamed, and the cæcum fixed. (*b*) Spread of gangrenous cellulitis to the bowel-wall after the removal of the appendix. (*c*) Damage to the bowel during the performance of the operation, either in the separation of the adhesions, or from the softened condition of the bowel-wall. In either of the latter circumstances the ileum may be the seat of the fistula. The strong tendency to rapid spontaneous closure of these fistulæ, even when a very large proportion of the contents of the small intestine escapes, must be borne in mind, and as a rule many weeks or even months should be allowed to elapse before any operation for their closure is undertaken (see p. 483).

Fistulous communications between the abscess cavity and the bladder, sloughing of the right ureter, or openings into the rectum or vagina.

All of these, except the ureteral complications, are unlikely to need special treatment, since they heal spontaneously. The unimportance of the bladder complication is very striking, the amount of cystitis produced being slight, in some cases nil; and spontaneous closure is the rule. Injury to the ureter may demand a plastic operation, or possibly the removal of the kidney.

Intestinal obstruction. This complication is most common in connexion with localized appendical abscesses, but may occur after appendicectomy operations where suppuration has occurred. It is most frequently due to kinking of adherent small bowel, and is readily relieved by operation. Rarely, large inflammatory masses may form in the pelvis, and give rise to obstruction of the large intestine. In such a case a temporary colostomy has even been needed.

Permanent adhesions may give rise to incomplete obstruction as a remote sequela, such obstruction occasionally needing relief by abdominal section and freeing of the implicated bowel.

Pulmonary complications. These form a considerable proportion of those observed after either operations in the acute, intermediate, or quiescent periods. The part played by the anæsthetic in their production is difficult to determine, but there is no doubt that a considerable proportion of the cases of bronchitis and pneumonia are to be ascribed to this cause. Pleurisy is more commonly the result of direct extension of the inflammation, while pulmonary embolism must be directly connected with thrombosis of the veins of the area of the operation itself.

Femoral thrombosis, more commonly of the left limb, has been observed with some frequency, and has been explained as due to an extension from the branches of the deep epigastric vein (Witzel), or to a too prolonged period of absolute rest in bed.

Contraction of the right psoas muscle; producing flexion of the corresponding hip. This only occurs in the comparatively rare instances of extension of serious inflammation to the muscle.

Catarrhal jaundice. As in cases untreated by operation, this complication is sometimes observed, more frequently after operations in the acuter stages.

Ventral hernia. This should never occur in cases in which either of the incisions recommended are employed, except when drainage has had to be maintained for a considerable period. When muscle is divided, however small the incision, ventral hernia occurs in a much larger proportion as a post-operative sequela.

OPERATIONS FOR PERI-APPENDICAL ABSCESSES

The choice of an incision for the drainage of an appendical abscess is primarily determined by the position of the abscess, but in certain cases it may also be influenced by the wish to utilize the resulting cicatrix for subsequent removal of the appendix.

For purposes of operation the abscesses may be considered under two headings. First, those which are thoroughly localized and connected by adhesion with the anterior or lateral abdominal wall; secondly, those which, although sharply localized, cannot readily be reached except by a route crossing the free peritoneal cavity.

The drainage of the first class offers little difficulty, the main points in the treatment being the exercise of care in planning the incision so as to cross the area in which the abscess is adherent to the abdominal wall, and the provision of an adequate opening for future escape of the pus. In order to meet the first point, a reliable sign of adhesion during the operation is usually offered by evidence of inflammatory infiltration of the deeper layers of the abdominal wall, and if this be absent the opening of the peritoneum should not be proceeded with before the margins of the wound have been laterally retracted, in the hope of finding a more suitable spot in the near neighbourhood. If the peritoneum be found free throughout the floor of the wound the further procedure must be as described below. To provide a sufficiently free exit opening it is often advisable to divide the muscle fibres rather than to separate and span them.

In the drainage of appendical abscesses across uninfected areas of the peritoneal cavity, the risk of diffusion of infection and setting up widespread or general peritonitis has been much lessened by the adoption of precautions suggested by the experience gained in operations for acute appendicitis. Indeed, the danger has been so nearly extinguished as to render the necessity of employing any of the special incisions mentioned below rare.

When the incision made to evacuate the abscess impinges on the free peritoneal cavity, the first step consists in careful displacement of the free intestine, until the inflamed area is reached. Gauze plugs are now introduced so as to hold back the normal bowel and to thoroughly protect the main cavity of the peritoneum. This ensured, the adhesions are carefully broken down at one point, and the pus rapidly absorbed as it escapes. When free flow has ceased, the abscess cavity is more widely opened up and its interior carefully wiped out with dry gauze. A large drainage tube and a surrounding gauze plug are introduced to the bottom of the cavity, the soiled retaining plugs being carefully withdrawn and replaced by a smaller plug if necessary. The plug and tube having been

arranged in the most convenient position in the opening of the abdominal wall, the tube is fixed by a stitch, and the wound may, if required, be reduced in size by the insertion of sutures.

If it should prove that the primary incision, although carefully planned, is in an inconvenient position both for immediate evacuation and subsequent drainage, two courses are open: (1) The abscess being now accurately localized, a second incision may be made directly over the adherent area, and the exploratory incision closed; the primary incision being sutured and protected prior to the escape of pus; or (2) the adhesions may be broken down with the finger, and the abscess cavity entered; the finger is then cut down upon from without, and the counter-opening is used for the permanent drainage of the cavity, a temporary drain being inserted by the primary incision.

The large majority of primary appendical abscesses are met with in the *right iliac* region, and here one of the type incisions for appendicectomy already described may be utilized. One or other can usually be made to cross the point at which the abscess cavity is nearest to, or has already reached, the anterior abdominal wall. In the greater number of cases McBurney's incision is the better situated, but some limitation must be placed on its general adoption, since the disturbance of the muscular layers favours the spread of infection in the abdominal wall, and the opening, from its tendency to rapidly contract, may provide only inadequate space for drainage. When the abscess is large, and especially when the bounding wall is very irregular, spanning of the muscle fibres is better replaced by incision, and indeed this rule obtains equally in incisions made in any other position.

When the abscess is situated near the median line, the rectus-sheath incision may always be employed, and is exempt from the disadvantages which pertain to the gridiron method. This incision is also generally preferable for pelvic suppuration.

Abscesses in the right lumbar region, or the left iliac region, are best opened over the point of greatest prominence, and this principle holds good in most of the other positions in which either primary or secondary abscesses may form.

Certain regions may be occasionally approached by special routes, such as the retrocæcal and pelvic.

Retrocæcal abscesses frequently attain large dimensions, even sufficient to obviously raise the abdominal wall in the line of the ascending colon without acquiring any anterior or wide lateral adhesion. Due regard being had to the remarks made below on the question of evacuating and draining appendical abscesses across uninfected portions of the peritoneal cavity, yet it is clearly preferable to avoid this complication if it

can be readily done. Two methods are at the disposition of the surgeon. When the abscess is low in the iliac fossa, the classical incision, one finger's breadth above Poupart's ligament, may be made, the muscles divided, and the extra-peritoneal cellular tissue exposed. The peritoneum is then carefully separated from the iliac fascia, and the cæcum lifted until the abscess cavity is reached. The second alternative is to approach the abscess from the loin. This method is more suitable to retrocæcal abscesses situated at a higher level.

Operations upon pelvic abscesses. Abscesses in the pelvis frequently require evacuation and drainage long before they reach the anterior abdominal wall. In such instances the small intestines are usually more or less distended and raised from their normal position; hence, if reached by an abdominal incision, a non-infected area of some extent frequently needs to be traversed. Under these circumstances some risk may be avoided by opening the abscesses from below, by an incision through the rectum or vagina into the pouch of Douglas. This method has the disadvantage of partaking of the character of a stab in the dark, but it is somewhat widely employed, although much less so since experience has shown that, with proper precautions, drainage may be safely established across an uninfected portion of the peritoneal cavity.

If the rectal route be chosen, the anus is first fully dilated, both for purposes of immediate convenience and to facilitate the later escape of pus. The rectal mucous membrane is then incised, and the further perforation effected by means of a blunt dissector or a pair of forceps. When the pus is reached, the opening is sufficiently dilated. The retention of a drainage tube is not practicable or advisable, since it opens the way not only for the escape of pus, but also for the entrance of fæcal matter into the abscess cavity.

When the vaginal route is preferred the procedure is similar, the primary incision being made in the posterior fornix, and the opening is again completed by a blunt instrument. Vaginal drainage is more commonly employed in the form of a counter-opening, the pelvic abscess having been previously opened from above. The risk of injuring adherent coils of intestine by either route of incision goes far to counterbalance the advantage of avoiding the free peritoneal cavity; hence, the use of these methods should be restricted to cases in which the general condition of the patient renders the risk of an abdominal incision unusually great.

Operations for abscesses in the upper regions of the abdomen due to extension. Appendical abscesses as the result of extension are frequently far distant from the original focus of disease. The extension is usually of a direct character, but rarely it may be the

result of a spreading lymphangitis, or an accompaniment of local septic phlebitis, or pylephlebitis and portal pyæmia.

The routes by which extension to the upper abdomen may travel are shown in Fig. 233.

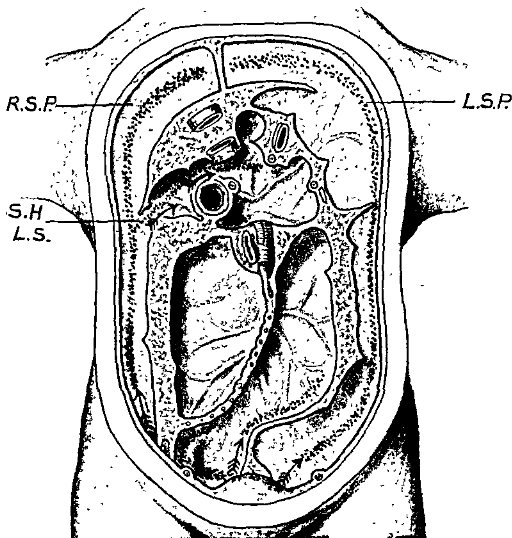


FIG. 233. ROUTES BY WHICH SUPPURATION MAY TRAVEL FROM THE RIGHT ILIAC FOSSA. Modification of Cunningham's diagram of the mesenteric attachment. R.S.P., right subphrenic; L.S.P., left subphrenic; S.H., subhepatic; L.S., route to lesser sac.

Abscesses ascending by the *right lumbar fossa* usually originate in connexion with an appendix lying to the outer side of the cæcum. They may extend inwards at the level of the hepatic flexure of the colon and occupy the hepato-renal pouch, forming the subhepatic variety, and from this position the pus very occasionally enters the foramen of Winslow and may travel across behind the stomach to the left half of the abdomen.

Subhepatic abscesses. These are most conveniently opened by an incision in the right loin below and corresponding in direction with the last rib. The condition of the peritoneum should be carefully observed when it is reached, and it may be possible to evacuate the pus without opening the general peritoneal cavity. If this be not the case, the peritoneal cavity should be plugged before the pus is evacuated by the finger. In early cases the condition may more nearly approximate itself to a localized peritoneal infection than a true abscess, only highly stinking turbid fluid being evacuated. The character of the effusion may also depend on the resistance shown to a bacillus coli infection by the individual, and possibly on the particular virulence possessed by the organism concerned.

Subhepatic abscesses may exist in connexion with an extension to the upper surface of the diaphragm; if this be so the two cavities may be drained by the same incision, tubes being passed over the upper and under surfaces of the liver. In a case of the writer's, a collection in the lesser sac of the peritoneum was successfully drained by the lower tube, without the necessity of any further incision.

When the abscess is truly *subphrenic* and limited to the intraperitoneal space between the upper surface of the liver and the diaphragm, a posterior transpleural incision is the best method of treatment.

The patient is placed on the left side, and the trunk rotated to the three-quarters prone position.

The diagnosis is first confirmed by preliminary puncture with a full-sized aspirating needle, passed to the depth of 3 inches through the lower intercostal spaces in the line of the angle of the scapula. The three or four lower spaces may need to be searched, and a second series of punctures may be necessary in the mid axillary line. These abscesses are, however, more commonly situated in the posterior part of the space, and limited anteriorly by adhesion between the liver and the diaphragm.

It must be borne in mind that two sources of fluid may exist, *e.g.* the pleura and the subphrenic space The pleural collection only may be reached; if this forms the primary escape the pleural effusion is abundant, or if the fluid only escapes with the withdrawal of the needle it may be small in amount. If clear or turbid fluid only be evacuated, no further interference with the pleural sac is indicated; if it be purulent, an empyema has to be dealt with.

When pus is found beneath the diaphragm, 3 inches of the most suitable rib is excised. This should be one of the lower five; above the seventh rib the diaphragm cannot be approximated to the intercostal muscles to close the pleural space. If the pleural space proves to be unobliterated by adhesions, the margins of the opening must be stitched to the surface of the diaphragm, and the abscess is incised. Barnard

(*Brit. Med. Journ.*, 1908, vol. i, p. 371) has laid stress on the importance of suturing the diaphragm to the intercostal wall in all cases, since with the evacuation of the contents of the abscess the diaphragm descends and recent adhesions become torn, opening up the pleural space secondarily. If adhesions be present, however, the suturing of the diaphragmatic opening to the thoracic wall is more easily and satisfactorily performed after the incision has been made. A large drainage tube, penetrating to the whole depth of the cavity, should be inserted.

Retrocolic suppurations may extend upwards in the retroperitoneal tissue in the line of the colon, and reach the posterior surface of the liver, forming extra-peritoneal subphrenic abscesses. In the earlier stages they may be reached by a right loin incision; the writer has successfully opened one by an anterior incision. This abscess formed a prominence below the liver, while there was no fullness in the right iliac region. The incision into the abdomen revealed a free peritoneal cavity, the abscess bulging the upper layer of the transverse mesocolon. After plugging off the surrounding area the abscess was opened and drained. The appendix (retrocæcal in position) was removed three months later.

When subphrenic, these abscesses are best reached by the posterior transpleural route.

Perisplenic abscesses are generally secondary to pelvic suppuration. They travel by the left lumbar fossa at the outer margin of the descending colon. They usually demand a posterior transpleural incision, occasionally they may be reached by a left loin incision. The latter is preferable in view of the direction from which the extension has come.

Barnard (*loc. cit.*, p. 376) has drawn attention to the advantages gained by delaying operation on subphrenic collections for a few days when the local signs are not extensive. He points out that a wait of three or four days allows the abscess to enlarge, which it does by pressing down the abdominal viscera; this permits the operation to be done at a lower and more satisfactory level, and also renders the probability of pleural adhesion much greater. In some cases it may even allow a subcostal incision,—an undoubted advantage.

PROGNOSIS AND RESULTS

The general mortality after operations for diseases of the appendix may be said to vary from 2% (Murphy, *Keen's Surgery*, vol. iv, p. 778) to 12%, if the results of a large number of operators under varying conditions are reviewed. The mortality rises and falls with the relative number of acute and complicated and quiescent cases included in any given set of statistics; it depends, in fact, upon whether the primary

disease or its secondary consequences assume the place of first importance in the cases operated upon.

To obtain a fair view of the actual operative mortality it is necessary to divide the operations into two classes: (1) those performed during quiescent intervals of the disease, (2) those performed in the presence of acute conditions.

Mortality after interval operations. Little requires to be said with regard to appendicectomy during a quiescent period. It has been fully proved that the mortality attending this procedure is under 1 %, in spite of the fact that many of the operations are of considerable severity. The main factor in ensuring success lies in the choice of a moment for the operation in which not only all acute or slighter symptoms have subsided, but also when it may be assumed that all traces of infective material in the neighbourhood of the appendix have disappeared. Such accidents as occur, apart from those attributable to actual faults in operative technique, are usually due either to the disturbance of small localized infective areas which escape notice during the operation, or to the diffusion of infective material from the interior of the appendix during the process of its sequestration and removal.

Many individual operators have published series of 100 to 200 operations without the occurrence of a single fatality, while such large numbers as 2,000 with one death (0·005 %, Murphy), 702 with two deaths (0·28 %, Roux), or 695 with four deaths (0·51 %, Kümmell) have been reported.

Mortality after operations for acute appendicitis. More detailed consideration becomes necessary in dealing with the results of removal of the appendix in the presence of acute conditions, in consequence of the frequency with which serious complications have already developed when the patient comes into the hands of the surgeon.

It may be said that this contingency should not have to be taken into account, but unless the conclusion that all cases of appendicitis are to be dealt with by immediate operation is generally arrived at, which opinion is far from universally held in this country, the treatment of complicated cases will remain one of the serious problems of surgery. Under existing conditions of professional opinion, the hospital surgeon or the consultant frequently sees cases of appendicitis under one of two conditions, either to confirm a diagnosis in view of the ulterior procedure of an 'interval' operation, or because the attack is of unusual severity and has developed serious peritoneal complications. Hence the surgeon first comes into contact with patients at the termination of the second or the commencement of the fatal third day, far more commonly than on the first

or second days, when a really 'early' operation can be taken into consideration.

For a satisfactory estimation of the results of operations during the acute stages, the classification adopted by Sprengel (*Deutsche Chirurgie*, Appendicitis, 1906, p. 569) is the most convenient. Thus, 'early operations,' those undertaken during the first 48 hours, 'intermediate operations,' those performed on from the second to the sixth day inclusive, and 'late operations', those performed from the sixth day onwards.

Mortality after early operations. In this category are included two very different sets of cases from a prognostic point of view: (1) those in which the inflammation of the appendix is accompanied by no more than simple reactionary changes in the peritoneum, (2) those in which definite peritoneal infection has already occurred.

The former class includes cases of simple catarrhal appendicitis, and also a considerable number of instances of acute general gangrene of the appendix. The results of appendicectomy for either of these conditions are almost as good as those of the interval operation, and their inclusion in the general results of early operations is the main factor in the attainment of the low mortality experienced by surgeons who most strongly support an active attitude in the treatment of appendicitis in its acute stage.

In the early operation, peritoneal infection does not acquire the enormous importance it possesses for operations in the intermediate stage. If, however, nearly the whole of the first 48 hours have been allowed to elapse, the area of the peritoneum infected may be considerable and the consequent systemic infection severe, especially in children, with a corresponding grave prognosis. Of 22 such cases in my own practice 4 died (16·1%); Nitch (*Lancet*, 1908, vol. i, p. 1761) reports 13 cases with 1 death (7·6%), and in Sprengel's series of 15 patients with diffuse peritoneal infection, 4 died (26·6%).

Mortality after intermediate operations. Appendicectomies performed between the second and seventh days of the disease afford the worst results. When peritoneal infection is diffuse, the prognosis is affected both by the duration of the condition and the area of the peritoneal cavity implicated.

Duration is of importance as denoting the degree of systemic infection reached, and it should be borne in mind that the general appearance of patients in whom infection has been in existence for some days by no means always corresponds with the actual gravity of their condition. The subjects may be bright-eyed and cheerful and yet prove quite unequal to resist the sudden increase in toxæmia which results from absorption

by the freshly cut surface of the operation wound, and rapidly succumb after an appendicectomy.

The extent of the peritoneal cavity implicated is of little less prognostic significance than the duration of the infection. Amongst my own cases I have separated those in which the process had not extended beyond the right half of the abdominal cavity, from those in which the affection had spread to the left half, and the percentage mortality for the former is 42 against 77 for the latter.

General experience has shown the mortality of appendicectomies performed in the 'intermediate' period in the presence of diffuse peritoneal infection to reach 50%, or much more, even as high as 80%. Nitch (*loc. cit.*) reports 17 cases with 2 deaths (11·7%). When the resistance of the patient has allowed of the occurrence of some localization, the mortality falls to 15–20%.

Mortality after late operations. Appendicectomies performed after the sixth day have a relatively favourable prognosis. This is dependent on the facts either that a localized infection has to be dealt with, or that if diffuse infection is present, it is commonly the result of extension from a previously localized centre, and is attacked early as far as the general infection is concerned. With regard to the latter point, however, the local condition may severely compromise the possibility of dealing satisfactorily with the recent diffuse infection, and, moreover, it is in cases of this class that subsequent creeping extension of the infection is particularly to be feared. The general mortality of late operations does not differ materially from that experienced in intermediate operation where the infection has localized itself, and may be placed at about 20%.

The above remarks are based on a consideration of the published results of English and Continental surgeons, but recent American statistics are of a far more favourable character. Whether this latter fact depends on the comparatively early stage in which the operations have been performed, or on the increased skill with which they have been carried out, is somewhat difficult to determine. No doubt the first point is of importance, and although 'early' operation in all cases is by no means the universal rule in America, yet it is reasonable to assume that the practitioners in the immediate entourage of certain distinguished operators may furnish cases in an earlier stage than surgeons in this country commonly have to deal with. On the other hand, it cannot be supposed that American surgeons entirely escape the complicated cases which are so unpleasantly familiar in this country. Unfortunately the means are not to hand for the classification of the American results in the manner employed in this article, but a paper by Murphy on Perforative Peritonitis (*Surg. Gynæc. and Obst.*, June, 1908, p. 565) affords information as to his treatment of

diffuse peritoneal infection, which demands the gravest attention. The two main principles involved are prompt intervention and a minimum of local interference (see Chap. XIV). Nitch's general result of a 10% mortality in thirty cases of appendicitis accompanied by diffuse peritonitis is obtained by the application of the same principle.

Mortality after operations for local abscess. The prognosis of well localized suppurations acquires especial interest from the claim which has been made of their occurrence terminating the liability to further attacks of appendicitis, even when treated by simple incision and drainage.

The condition is liable to be accompanied by many of the complications of the disease in general; thus of 59 cases serious complications were met with in 22 (intestinal obstruction 5, fæcal fistula 6, spontaneous opening into the bladder 2, and into ureter 1, subdiaphragmatic abscess 3, empyema 3, cerebral abscess 1, pulmonary abscess 1), and 7 of the patients (13·4%) died.

Of the cases in which the future course has been able to be followed, 23, or 39·9%, are known to have suffered from recurrences, and in 17 of these the recurrence was accompanied by suppuration. All the patients were recommended to undergo an 'interval' operation, with the single exception of one case in which the gangrenous appendix was found floating free in the cavity of the abscess. In 18 a subsequent interval operation was actually performed, and in all an appendix was found capable of giving rise to further attacks; all recovered.

Finally, it may be stated that a general review of the published results of appendicectomy appears to show clearly that the 'early operation', if performed as a routine procedure, would lead to the disappearance of practically the whole of the complications which at the present time account for the fatalities which occur; further, that the 'early operation' may be fairly placed in almost the same category as regards mortality with that performed during a quiescent interval.

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General experience has shown the mortality of appendicectomies performed in the 'intermediate' period in the presence of diffuse peritoneal infection to reach 50%, or much more, even as high as 80%. Nitch (*loc. cit.*) reports 17 cases with 2 deaths (11·7%). When the resistance of the patient has allowed of the occurrence of some localization, the mortality falls to 15–20%.

Mortality after late operations. Appendicectomies performed after the sixth day have a relatively favourable prognosis. This is dependent on the facts either that a localized infection has to be dealt with, or that if diffuse infection is present, it is commonly the result of extension from a previously localized centre, and is attacked early as far as the general infection is concerned. With regard to the latter point, however, the *local condition may severely compromise the possibility of* dealing satisfactorily with the recent diffuse infection, and, moreover, it is in cases of this class that subsequent creeping extension of the infection is particularly to be feared. The general mortality of late operations does not differ materially from that experienced in intermediate operation where the infection has localized itself, and may be placed at about 20%.

The above remarks are based on a consideration of the published results of English and Continental surgeons, but recent American statistics are of a far more favourable character. Whether this latter fact depends on the comparatively early stage in which the operations have been performed, or on the increased skill with which they have been carried out, is somewhat difficult to determine. No doubt the first point is of importance, and although 'early' operation in all cases is by no means the universal rule in America, yet it is reasonable to assume that the practitioners in the immediate entourage of certain distinguished operators may furnish cases in an earlier stage than surgeons in this country commonly have to deal with. On the other hand, it cannot be supposed that American surgeons entirely escape the complicated cases which are so unpleasantly familiar in this country. Unfortunately the means are not to hand for the classification of the American results in the manner employed in this article, but a paper by Murphy on Perforative Peritonitis (*Surg. Gynæc. and Obst.*, June, 1908, p. 565) affords information as to his treatment of

diffuse peritoneal infection, which demands the gravest attention. The two main principles involved are prompt intervention and a minimum of local interference (see Chap. XIV). Nitch's general result of a 10% mortality in thirty cases of appendicitis accompanied by diffuse peritonitis is obtained by the application of the same principle.

Mortality after operations for local abscess. The prognosis of well localized suppurations acquires especial interest from the claim which has been made of their occurrence terminating the liability to further attacks of appendicitis, even when treated by simple incision and drainage.

The condition is liable to be accompanied by many of the complications of the disease in general; thus of 59 cases serious complications were met with in 22 (intestinal obstruction 5, fæcal fistula 6, spontaneous opening into the bladder 2, and into ureter 1, subdiaphragmatic abscess 3, empyema 3, cerebral abscess 1, pulmonary abscess 1), and 7 of the patients (13·4%) died.

Of the cases in which the future course has been able to be followed, 23, or 39·9%, are known to have suffered from recurrences, and in 17 of these the recurrence was accompanied by suppuration. All the patients were recommended to undergo an 'interval' operation, with the single exception of one case in which the gangrenous appendix was found floating free in the cavity of the abscess. In 18 a subsequent interval operation was actually performed, and in all an appendix was found capable of giving rise to further attacks; all recovered.

Finally, it may be stated that a general review of the published results of appendicectomy appears to show clearly that the 'early operation', if performed as a routine procedure, would lead to the disappearance of practically the whole of the complications which at the present time account for the fatalities which occur; further, that the 'early operation' may be fairly placed in almost the same category as regards mortality with that performed during a quiescent interval.

CHAPTER XIII

OPERATIONS FOR INTESTINAL OBSTRUCTION

GENERAL CONSIDERATIONS

Operations for the relief of intestinal obstruction are so varied in detail as to be most conveniently considered under the special headings corresponding to their nature.

Indications. Certain broad indications for operation are common to all varieties, such as pain, vomiting, and complete or incomplete obstruction to the passage of flatus or fæces, these symptoms being followed by those of intestinal toxæmia, often by peritonitis, and, if the condition remains unrelieved, by death.

Preparations for operation. The condition of the patient is often bad, and in cases of acute obstruction especially the operations are of an 'urgent' nature. The first precaution should be directed to the temperature of the room in which the operation is to be performed, which should not be below 68° F. Next, care should be taken to see that the patient is well clad; for this object the limbs may be encased in cotton-wool and flannel bandages, and the table should be kept warm by hot bottles so arranged as to run no risk of burning the patient.

Cleansing of the abdominal wall should be carried out with as little expenditure of time and exposure of the patient as possible, and due precautions should be taken during the washing that the table on which the patient lies is not soaked. An abdominal apron, provided with an opening opposite the site of the wound, is an advantage in view of the hasty preparation of the skin which has been possible.

When vomiting is a prominent symptom, the stomach should be washed out. This procedure avoids the risks attendant on aspiration of vomit which may be imperfectly ejected during the operation, and relieves a stomach often objectionably dilated; it is preferably carried out prior to the administration of the anæsthetic. When the general condition of the patient is bad, especially if attended by great abdominal distension, a hypodermic injection of a thirtieth of a grain of strychnine may be administered with benefit.

The most satisfactory anæsthetic is chloroform, or a mixture of chloroform and ether. When the condition is such as to warrant at the most the performance of an enterostomy, local infiltration anæsthesia

may be employed, but this method is not convenient or advisable if more extensive measures are contemplated.

Operation. The foot of the table should be raised, or a modified Trendelenburg position arranged which helps to counteract the tendency of the loaded bowel to protrude. When the seat and nature of the obstruction are undetermined, a paramedian incision commencing just above the level of the umbilicus, with displacement of the rectus, provides the most convenient route of access, and allows of ready extension if needed.

When the abdomen is opened, distended coils of intestine are exposed and tend to prolapse, and it is at this period of the operation that the anæsthetization needs to be deepest. Care should be taken to prevent the escape of intestine at this stage, since its exposure favours further distension and an increase in general shock.

It is most important that the search for the seat of obstruction should be made systematically, otherwise much valuable time may be lost. Points in the history or local signs may indicate the advisability of searching certain regions first, but in the absence of these the condition of the cæcum may be best at once determined, as distension or a contracted state of this localizes the obstruction in the large or small bowel respectively. If the cæcum be contracted and empty, an attempt should be made to find a collapsed portion of the small intestine in the pelvis, and in the course of this attempt the various 'hernial openings' may be rapidly passed in review. If collapsed intestine be discovered, the gut should be as rapidly as possible passed through the hands, an assistant replacing each length of bowel as it is drawn out by the surgeon. The degree of distension of the intestine may render this mode of procedure impossible, in which case either a considerable extent of the small intestine must be allowed to escape into warm towels, or the intestine may be unloaded by an enterotomy (see p. 398). The latter procedure is preferable, especially in the presence of signs of intestinal toxæmia.

If the cæcum be loaded, the sigmoid flexure must next be examined, and then the remainder of the colon. In searching the large intestine it is important to bear in mind that the gut on the distal side of the obstruction is occasionally 'ballooned', hence every effort must be made to localize the actual point of obstruction; want of attention to this rule has occasionally led to the performance of a colostomy on the distal side. It is in cases of obstruction due to malignant growths that this phenomenon is most commonly met with; it resembles in nature the corresponding condition of the rectum when malignant disease affects that portion of the bowel.

If a considerable degree of escape of distended bowel has been inevitable, its replacement may be a matter of great difficulty. This may be facilitated by evacuation of the contents of the bowel, or more rapidly by the

'towel method' of Murphy. The exposed intestine is covered by a towel, the margins of which are tucked in to the abdominal cavity around. The abdominal wall is now lifted on either side alternately by an assistant, and by means of pressure and manipulation the intestines are made to re-enter the abdominal cavity. The towel is withdrawn gradually during the progress of suture of the abdominal wound. In less difficult cases an excellent broad metal retainer to insert during the introduction of the sutures has been devised by P. W. G. Sargent (see Fig. 234).

After-treatment. Post-operative vomiting may at first be due to the anæsthetic, and then is to be treated if it continues by free draughts of warm water, or a tumbler of water containing a drachm of sodium bicarbonate. The occurrence of vomiting of this class may often be prevented by allowing the patient to inhale a small amount of oxygen until the effects of the anæsthetic have passed off.

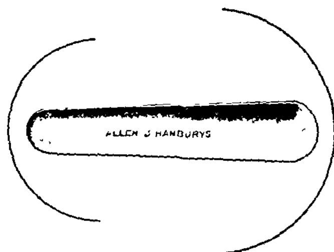


Fig. 234. Sargent's Intestine Retainer.

More persistent vomiting may be checked by the administration of half a grain of cocaine, or five minims of tinct. iodi in a tumbler of water. When the vomit continues to be of the offensive character existent before the operation, washing out of the stomach with warm water is advisable.

Hypodermic injections of one-sixtieth of a grain of strychnine may be given to counteract shock, and these are also useful when there is much abdominal distension. Shock and thirst are to be combated by the administration of enemata of normal saline solution, one pint every four or six hours; in bad cases, especially those in which intestinal toxæmia is marked, continuous proctoclysis after the method of Murphy is desirable, 1½ pints being introduced during each two hours (see p. 559).

Peristalsis is to be encouraged by the administration of repeated small doses of calomel, a grain every two hours until five grains have been taken. Turpentine enemata may be useful to relieve distension and encourage the passage of flatus; hypodermic injections of eserine salycilate gr. $\frac{1}{100}$ may be given with the same object in conjunction with a dose of magnesium sulphate. On the third day a purgative is generally desirable, and in cases of intestinal toxæmia purgation may often be commenced earlier.

General results of operations for intestinal obstruction. The results obtained by these operations up till the present leave much to be desired, although a more general appreciation of the necessity of early operation, and of the ill-effect of delay, has been followed by a certain amount of improvement.

The following tables give the results of 400 operations performed for obstruction due to simple causes, and of 143 performed to relieve obstruction occasioned by malignant disease.

The operations represent the entire consecutive series performed in a large London hospital during the twenty years ending with December, 1907, and possess the great advantage over any collection of cases from outside sources of including every patient operated upon, while the operations have been performed by a number of different surgeons.

Of 400 patients operated upon for obstruction from simple causes (excluding external herniæ), 227 died, or 56·7 %. Of 143 patients suffering from obstruction from malignant disease, 92 died, or 64·3 %.

If the cases operated upon during the last five years of the period are separated, some improvement in the results is shown.

Thus, simple cases, 155; died, 70, or 45·1 %. Malignant cases, 79; died, 48, or 60·7 %.

FOUR HUNDRED CASES OF INTESTINAL OBSTRUCTION FROM SIMPLE CAUSES, ST. THOMAS'S HOSPITAL, 1888–1907.

Nature.	*Total.*	*Recovered.*	*Died.*	*Percentage mortality.*
Intussusception	202	109	93	46·3
Volvulus	29	10	19	65·5
Broad Peritoneal Adhesions	60	24	36	60·0
Cicatricial Bands	42	11	31	73·8
Mesenteric Holes	5		5	100·0
Meckel's Diverticulum	22	8	14	63·6
Adherent Appendix	1		1	100·0
Opening in Mesocolon	1		1	100·0
Opening in Omentum	1	1		
Strangulation in Retroperitoneal Fossa	1		1	100·0
Properitoneal Hernia	1		1	100·0
Retroperitoneal Hernia	1	1		
Diaphragmatic Hernia	1		1	100·0
Cicatricial Stricture	9	1	8	88·8
Impacted Gall-stone	5	1	4	80·0
Fæcal Impaction	1	1		
Angulation of Sigmoid	1		1	100·0
Idiopathic Dilatation of Colon	3	2	1	33·3
Gangrenous Ileum, ? cause	1		1	100·0
Acute Obstruction, ? cause	9	3	6	66·6
Uterine Fibroids	3		3	100·0
Lipoma of Sigmoid	1	1		
	400	173	227	56·7

One Hundred and Forty-three Cases of Obstruction consequent on Malignant Disease, 1888–1907.

Situation.	*Total.*	*Recovered.*	*Died.*
Ileum	2		2
Cæcum	7	1	6
Ascending colon . .	2		2
Hepatic flexure . .	7		7
Transverse colon .	4	1	3
Splenic flexure . .	12	7	5
Descending colon . .	6	1	5
Sigmoid flexure . .	67	22	45
Rectum	28	15	13
Colon, ? site . . .	2	1	1
Stomach	1		1
Ovary	2	1	1
Cervix Uteri . . .	1	1	
Uterus	1	1	
Pelvic Tumour . .	1		1
	143	51	92

Percentage mortality, 64·3.

OPERATIONS UPON SPECIAL FORMS OF OBSTRUCTION

SYMPTOMATIC OBSTRUCTION

Indications. The commonest form is that accompanying peritonitis consequent on infection. Organic obstruction may also be simulated in cases of injury to, or disease of, the abdominal viscera. Thus, signs of obstruction may follow severe blows, retroperitoneal hæmorrhage resulting from injury, fractures of the spine; the passage of biliary or renal calculi; torsion of the testis, the pedicle of an ovarian cyst tumour, or a floating kidney; and acute pancreatitis.

Symptomatic obstruction characterized by great distension, sometimes persisting for weeks, may be due to hysteria, comparable in its nature to the pseudo-paralysis often noted in the limbs. Of a similar nature is the opposed condition of enterospasm, especially liable to occur in the large intestine.

Of these forms of symptomatic obstruction operation on the intestine is sometimes indicated in the case of peritoneal infection (see p. 558). Certain forms of symptomatic obstruction are of more importance from the point of view of operation, such as those accompanying torsion of the omentum, and embolism or thrombosis of the mesenteric vessels.

Torsion of the omentum may occur within the abdominal cavity, or in a hernial sac, in this respect closely resembling the allied condition of volvulus of the intestine. The symptoms vary; in some cases the bowels act, or even diarrhœa may be present; in others flatus

only is passed, or obstruction may be absolute. *The indications for operation* consist in pain, the presence of a tumour in the abdomen, or signs of strangulation or incarceration in a hernial sac. A rise in the temperature and pulse rate of moderate degree accompanies these signs. Cases have been operated upon usually on a false diagnosis.

The operation consists in the removal of the twisted portion of the omentum, the point which needs divsion being frequently a more or less atrophied pedicle. When the twisted portion is within a hernial sac the omentum can be readily drawn down. In instances of torsion within the abdomen, the paramedian subumbilical rectus-sheath incision is the best. In the six cases of pure abdominal torsion collected by Corner and Pinches (*Trans. Med. and Chir. Soc.*, 1905, vol. lxxxviii, p. 611), the tumour was situated in the right half of the abdomen, which fact would clearly indicate the most suitable site of incision to the operator.

OBSTRUCTION DUE TO ARTERIAL EMBOLISM AND VENOUS THROMBOSIS

Indications. The arrest of the embolus is followed by a short stage of irritation evidenced by increased peristaltic activity, bloody diarrhœa (in 34·7% of 46 cases, Wilms, *Path. und Klinik des Darmverschlusses*, 1906, p. 116), vomiting, which in a few instances has been noticed to be sanious, and distension of the abdomen. These preliminary symptoms are followed by those of absolute obstruction. When the obstructed arterial branch is small and a limited area of the small intestine is affected only, distension of the affected coil and hardening of its wall may give rise to a localized elongated tumour which simulates an intussusception. When the embolus lodges in a branch of the inferior mesenteric artery, in addition to bloody diarrhœa, tenesmus and a patent anus have been observed.

Signs of obstruction of a similar character less frequently develop as a result of thrombosis of the mesenteric veins. The symptoms may be somewhat less acute, while the history often indicates the origin and nature of the lesion. Thus, ascending thrombosis may follow inflammation about the anus, pelvic organs, or the appendix; descending thrombosis has been observed in connexion with syphilitic disease or cirrhosis of the liver, pylephlebitis, or operations of the gall-bladder, bile ducts, duodenum, or pancreas. In Bradford's case (*Trans. Clin. Soc.*, 1898, vol. xxxi, p. 203), the thrombosis was apparently secondary to suppuration of the mesenteric glands.

The occurrence of the above train of symptoms, whether due to embolism or to thrombosis, indicates the necessity of an abdominal

exploration, provided the general condition of the patient warrants the procedure.

Operation. The ideal procedure is an enterectomy, in the performance of which the following points are to be borne in mind:—

When a definite tumour has been previously located, its position determines the most suitable level for the incision. In the absence of this indication a paramedian incision with outward displacement of the rectus, starting from the level of the umbilicus, is the most suitable, since in the great majority of instances the small intestine needs to be dealt with.

On opening the peritoneal cavity, blood-stained fluid will probably escape in early operations; in later ones inflammatory exudation and the presence of lymph on the intestines are more likely. The affected portion of bowel may be bright red, ecchymosed, blue and stiff, or possibly gangrenous, and is usually readily palpable. The corresponding mesentery is also stiff and ecchymosed, or the thrombosed vessels may be felt.

Distension of the bowel is commonly a prominent feature, a matter of great moment, since fouling of the peritoneal cavity by intestinal contents has occurred in a considerable proportion of the cases operated upon. A preliminary enterotomy and evacuation of the contents of the bowel should therefore precede the performance of the enterectomy if much distension exists.

Sufficient bowel should be removed to ensure that the parts to be united receive a direct blood-supply. In five successful operations for thrombosis the length needing removal varied from 3½ to 48 inches, and on two occasions a Murphy's button was employed as the means of union.

In the small intestine an axial union is generally preferable. In the colon it may be better to unite the bowel by the lateral method, or to make a primary lateral anastomosis, and then resect the portion of damaged colon.

The patient's condition may render it necessary to rapidly resect the affected portion of intestine, and establish a temporary enterostomy with the aid of Paul's tubes. In the small intestine this plan is naturally undesirable, but it may give time, and tide the patient over the immediate risk.

Prognosis and results. The prognosis depends primarily on the length of the gut implicated; secondarily, on the general condition of the patient, and the time which is allowed to elapse prior to the performance of the operation. Haagn (*Deutsche Zeitschr. f. Chir.*, 1908, vol. xcii, p. 79) points out that the most satisfactory cases for operation are those in which acute symptoms of obstruction are marked, and it is in such that the indications for exploration are clearest.

Brunner (*Deutsche Zeitsch. f. Chir.*, 1907, vol. lxxxix, p. 624) has collected 125 cases of arterial thrombosis, of which 26 underwent operative treatment, and 2 only recovered (mortality 92·3 %). In the same paper 89 cases of venous thrombosis are collected, of which 31 underwent operation, and 4 recovered. To these 31 cases may be added the 2 successful ones recorded by Brunner and Haagn, which reduce the mortality to 81·8 %.

INTUSSUSCEPTION

Indications. Symptoms of acute obstruction, or, more rarely, of intermittent or incomplete obstruction in subacute or chronic cases. The following features point to the special nature of the condition present:—

Sudden pain, which may be persistent, but is more commonly intermittent, and of a colicky character. Vomiting, at first reflex, which later may become continuous. Even in untreated cases it rarely acquires fæcal characters (25 %). When active, vomiting tends to prevent the development of distension and is to some extent a favourable moment both as regards diagnosis and treatment. The passage of blood-stained mucus or blood and mucus in the stools. This sign is less constant in enteric intussusceptions, and is more frequently observed in adults than in children. Chronic intussusceptions are often accompanied by diarrhœa.

Examination of the rectum may allow the apex of the intussusception to be felt. In such cases especially there may be tenesmus. On palpation, an elongated tumour may be felt in the abdomen; this sign is fairly constant, but it must be remembered that the tumour is often palpable only during an attack of enterospasm and pain, when it may be felt to harden under the hand; again, that the position of the tumour shifts with the advance of the invagination. This latter fact sometimes allows a definite want of resistance in the right iliac fossa to be determined (Signe de Dance). Enteric intussusceptions are generally palpable in the neighbourhood of the umbilicus; the other varieties in the course of the colon.

It is important to bear in mind that infants and children, the subjects of intussusception, are often particularly strong and healthy, and during the first twenty-four hours they may look remarkably well, suffering from pain only at intervals, while the pulse rate is little quickened.

An intussusception of any form or variety demands an abdominal section at the earliest possible moment after its detection. Treatment by inflation or injection is always untrustworthy and generally useless.

Operation. The most suitable site for the abdominal incision

is subumbilical and through the sheath of the right rectus muscle. The muscle may be displaced either inwards or outwards; if the intussusception be extensive the latter direction is preferable, since it facilitates access to the left half of the abdomen.

Prior examination may have determined the position of the apex of the intussusception, and in this case it may be dealt with at once. If the position of the intussusception has not been able to be defined, the cæcum should be first sought; if this be absent from the right iliac fossa, the colon must be traced, preferably from below upwards.

The apex of the intussusception having been discovered, it is steadily passed backward by pressure exercised by the finger and thumb on the containing bowel from below. The early part of this procedure is easy, but gradually becomes less so as the neck of the intussusception is reached. When the difficulty becomes pronounced, the intussusception should be brought into view, the wound, if necessary, being elongated for this purpose, and the final manipulation should be concluded by the employment of sight as well as touch. This part of the procedure is much facilitated by the envelopment of the compressing digits in a layer of gauze, and the addition of gentle traction on the intussuscepted part. It is at this stage of the operation that rents in the softened peritoneal covering of the bowel are in greatest risk of being produced, both by the resulting distension of the intussuscipiens, and the traction on the fixed point at the neck. Such rents are dangerous, as liable to lead to subsequent auto-infection, and they also favour the ulterior formation of adhesions. Every effort must therefore be made to avoid their production, and should they occur, the rents must be repaired by the introduction of fine sutures.

When reduction is complete, the swollen and œdematous mucous membrane, particularly the segments of the ileo-cæcal valve, may suggest the presence of a polyp in the interior of the cæcum. The explanation *of this condition must be borne in mind, since the false impression* produced by it has sometimes led to an unnecessary exploration of the interior of the cæcum.

Exploration of the abdomen and the necessary manipulation for reduction are to be as far as possible carried out without unnecessary exposure of the intestine—an important prognostic precaution—but in cases of difficulty it is preferable to allow some of the abdominal contents to escape into warm towels, rather than to expend valuable time and carry out the manipulation under manifest disadvantage.

Moynihan recommends that a few sutures should be finally inserted to fix the cæcum in position, on the ground that an abnormal mobility of the cæcum is responsible for the possibility of occurrence of extensive

ileo-cæcal intussusception. It may be remarked that recurrence of an intussusception after operative reduction is a rare event, possibly in part because the strain to which the bowel has been exposed does not permit the resumption of over-active peristalsis for some time.

The last portion of the intussusception having been douched with saline solution, the bowel is replaced and the abdomen closed. Rapidity of execution in the case of this operation is specially to be desired.

Difficulties. 1. Enteric intussusceptions, especially of more than twenty-four hours' standing, are less easy of reduction than the other varieties; the adhesion of the layers is more pronounced, probably on account of the favourable conditions offered by the smooth even wall of the small intestine for cohesion

2. Reduction of the invagination may prove impracticable, or the involved bowel may be hopelessly damaged by the manipulations exercised.

3. Gangrene of the intussusception may have already occurred.

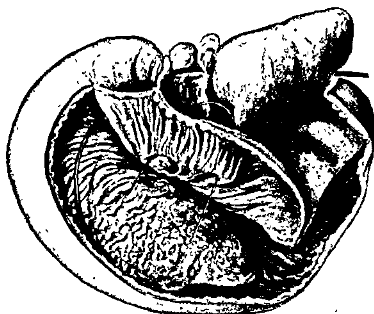


FIG. 235. ENTERIC INTUSSUSCEPTION OF EIGHT DAYS' STANDING. Gangrene at both the neck and apex of the intussusception. Separation of the neck has occurred. (*St. Thomas's Hospital Museum*, No. 1203 A.)

In either of the two latter events recourse must be had to enterostomy or enterectomy. Enterostomy is a highly undesirable alternative, and is to be reserved for cases in which the general condition of the patient forbids any but the most rapid procedure. If performed, a Paul's tube should be tied into either end of the intestine, and secondary closure should be attempted as soon as practicable. Very few patients survive in whom this course has to be taken.

In rare cases a substitute for enterostomy is to be found in a lateral anastomosis. This can seldom be the case in infants or children suffering with an acute intussusception, since the time needed for the operation is little less than that needed for the form of enterectomy to be below described; moreover, if an anastomosis be established it runs the risk of secondary occlusion by further descent of the intussusception. Lateral

anastomosis may, however, rarely be indicated in cases of chronic intussusception, in which the state of the patient renders an enterectomy too dangerous, and here the objection depending on possible secondary occlusion is less strong. In such cases an expectant attitude has been recommended, in order to allow the possibility of spontaneous separation of the intussusception; a safer course is to await a general



FIG. 236. ILEO-CÆCAL INTUSSUSCEPTION. Intussusceptum gangrenous. (*St. Thomas's Hospital Museum*, No. 1198.)

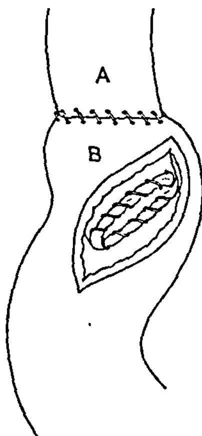


FIG. 237. DIAGRAM ILLUSTRATING TREATMENT OF THE INTUSSUSCEPTION SHOWN IN FIG. 236 BY THE JESSETT-BARKER METHOD.

improvement in the condition of the patient, and then proceed to its removal.

Where the reduction of the bowel has been practically completed, and enterectomy appears a necessity, or if the tissues of bowel beyond the intussusception itself have become infected by extension, a resection of the usual type must be performed, with the ordinary treatment of the mesentery. An axial union should be performed in the case of the small intestine, or a lateral union with closure of the free ends where small and large intestine are concerned

Where removal of the intussusception is decided upon at once, either on account of the initial difficulty experienced in its reduction, or on account of the doubtful state of vitality of the bowel, the operation conceived by Jessett, and carried out and perfected by Barker, Rydigier, and others, is preferable. The principle of the operation is founded on the observation that in some cases of subacute or chronic intussusception adhesion takes place at the neck, and the intussusception perishes and is passed spontaneously *per anum*. The result attained by the operation closely resembles that following an enterectomy by Maunsell's method.

For the performance of this operation the neck of the intussusception is drawn well forwards, and the normal gut clamped above, and if possible below. If the latter procedure be impracticable, by reason of the extent of the intussusception, the clamp must be placed on the whole mass and provisionally removed during the later withdrawal of the intussusception. The abdominal cavity and wound are protected by gauze plugs.

The entering gut is sutured to the prominent neck of the ensheathing segment, the line of suture being carried on to the mesentery in such a manner as to preserve the folds produced in it by the descent of the intussusception.

A longitudinal incision, 1 or 1½ inches in length, is made into the intussuscipiens ¾ inch below the neck, and from the opening thus obtained the intussusceptum is delivered, the lower clamp being provisionally removed if required.

The intussusceptum is now drawn forward, and its base is divided in segments, stitches through the whole thickness of the wall of the two elements being introduced as the division proceeds. Special care is to be exercised in dealing with the mesenteric margin, in order to prevent any risk of hæmorrhage from this part.

Lastly, the longitudinal incision in the bowel-wall is repaired by the introduction of two tiers of sutures, one perforating all the coats, and the superficial one of the Lembert type. Care should be taken not to include too great an extent of the bowel-wall, since a transverse closure of the wound is not advisable in these cases, in consequence of the near proximity of the other line of suture.

4. Other complications may be met with occasionally. The simplest is the discovery of an intestinal polyp as the original cause of the condition; much more rarely a simple tumour, such as a lipoma of the bowel-wall. In either case the removal of the tumour is indicated, a polyp being cut off at its base and the gap in the mucous membrane repaired over the resulting gap. For this procedure a simple longitudinal incision of the bowel-wall suffices. For a tumour of any size, either simple or of sarcomatous nature, a type resection of the affected portion

of intestine is required. A rare complication may be the discovery of the cause as a Meckel's diverticulum, when the removal of the latter will be indicated after the reduction of the intussusception.

5. Malignant growths of the large bowel of the annular variety not very infrequently become invaginated. When this occurs within the abdominal cavity, the case is to be treated on the lines which govern the surgeon in dealing with such growths in general. Occasionally, however, tumours of the pelvic or sigmoid colon descend to the anus, or even prolapse. This accident may be regarded as a happy one, since the operation for the relief of the condition is one of the easiest in connexion with the intestines. The growth is well drawn down, and then the base of the two thicknesses of bowel-wall is divided in segments, through and through stitches being introduced as the division is proceeded with. When released the line of suture either re-enters the anus spontaneously, or may be readily replaced. In fact, the line of suture may at once rise far out of the reach of the finger.

These operations have been followed by surprisingly good results, both immediate and remote, in spite of the fact that any interference with the lymphatic glands far from the margin of the bowel is impracticable. The mere fact of the possibility of such free prolapse indicates a condition of the mesentery which renders it improbable that extensive lymphatic infiltration has occurred.

Prognosis and results. Experience in operations for intussusception has clearly demonstrated the importance of early interference, and recorded statistics show that in operations performed during the first twenty-four hours, the results obtained compare favourably with those of all other forms of obstruction. Early operation excludes the probability of all the serious complications alluded to above, while the patients themselves usually offer the real advantage as subjects of being perfectly healthy up to the immediate occurrence of the accident. The second element of importance in the prognosis is the relative time spent in the reduction of the intussusception. There is no doubt that, especially in infants, a rapid operation is of the first moment, hence the operator should be careful to choose that method which ensures to him the greatest rapidity and involves the least amount of intra-abdominal manipulation and exposure of the intestines.

The general results of operations are in fact good, and the mortality which exists is in great measure to be ascribed to cases already complicated by the existence of gangrene, the supervention of peritonitis, or general toxæmia.

That even the formidable operation of complete resection is not in itself to be unduly feared, is shown by the results obtained by

von Eiselsberg (*Arch. f. klin. Chir.*, 1903, vol. lxix, p. 26), who records nine recoveries in twelve cases of ordinary intussusceptions treated by excision; mortality 25%. These results are of course not comparable with those of resections performed for gangrene, or in toxæmic patients. The latter class of case unfortunately still depresses the percentage of recoveries obtained in General Hospitals, and in consequence of the rarity of this condition amongst the children of the better classes it is to hospital records alone that we can look for information.

During the years 1888–1908 inclusive, 202 patients were consecutively submitted to operation of various forms at St. Thomas's Hospital; of these ninety-three died, a mortality of 46·3%. Of these operations twelve consisted in resection with immediate union, of which number only two adults recovered; and fifteen of enterostomy alone, or enterostomy combined with excision, of which number all succumbed. If the latter twenty-seven cases be subtracted, the mortality for abdominal section combined with reduction is reduced to 38·8%.

If the cases occurring during the last five years of the period are considered alone, the numbers are slightly better. Thus, of sixty-five cases, twenty-three died, a mortality of 35·3%. In this series nine cases of enterostomy, or resection, are included, with only one recovery (an adult); if these be subtracted we have fifty-six cases with fifteen deaths, a mortality for cœliotomy and reduction of 26 7%.

Clubbe (*Brit. Med. Journ.*, 1905, vol. i, p. 1327) records 100 consecutive operations with a mortality of 37%. He further divides these cases into two successive periods, each including fifty, and finds that while in the years 1893–1901 the mortality was 50%, in the years 1901–4 the mortality was reduced to 24%. Clubbe ascribes the improvement in the later results to the fact that the patients came earlier under observation. Cuthbert Wallace (*Clin. Soc. Trans.*, 1905, vol. xxxviii, p. 55) has recorded twenty consecutive operations with a mortality of 20%. Excluding cases in which resection was necessary, Wallace's mortality is decreased to 11·11%.

VOLVULUS

Indications. The indication for operation is usually acute intestinal obstruction of undetermined nature, except in the case of sigmoid or cæcal volvulus, where isolated distension of the loop is often sufficiently well marked to allow a distinctive diagnosis being made. The latter cases also frequently give a history of previous attacks of temporary obstruction of a similar character.

Operation. The primary incision should be subumbilical, this being the most suitable for dealing with either cæcal or sigmoid volvuli

or the exploration of the small intestine. If the signs indicate a cæcal or sigmoid volvulus the incision may be over the outer part of the rectus sheath, and the muscle is displaced inwards; for cases of indeterminate cause the paramedian position with displacement of the muscle outwards is preferable.

The abdominal cavity having been opened, the volvulus may present itself in several forms.

Volvulus of the small intestine. 1. In young patients, practically the whole small intestine may be implicated, appearing black and even gangrenous. This condition has most frequently been observed in young infants, and is accompanied by very acute symptoms. In such cases the ileal mesentery may be so deficient as to give rise to a much narrowed line of attachment to the posterior abdominal wall; or the cæcum having failed to descend and travel to the right, a similar narrowed area of fixation is present in spite of the possible existence of a common mesentery.

2. A local coil, or coils, only may be implicated. In this case adhesions may be present, either fixing the coil of intestine itself, or crossing the attachment of the mesentery in such a manner as to narrow its width. In other instances no definite cause for the torsion can be discovered. Volvulus of local coils is naturally the most common variety met with in connexion with herniæ.

When the volvulus is extensive, the ileum is always involved, sometimes the whole ileum and jejunum, but never the jejunum alone. Such cases are frequently hopeless, but the treatment consists in the untwisting of the intestine from right to left, and an attempt to fix the upper and lower extremities of the mesentery in such a manner as to render a second torsion impracticable. Five cases in which operation was successfully performed have been collected by G. Serda (*La Riforma Med.*, 1908, No. vii, p. 177).

When a volvulus affects a single loop of small intestine the treatment depends upon the variety; if the torsion has occurred as a result of rotation around an abnormal adhesion, or as a result of plication of the mesentery by a band, simple division of the latter is sufficient. Again, when a volvulus develops in, or in connexion with, a hernial sac, liberation of the loop and extirpation of the sac is alone indicated. If, on the other hand, no explanation of the twist is to be found in acquired conditions, the affected loop should be resected, and an axial union established if the state of the patient and the local condition of the bowel permit this step.

Volvulus of the large intestine. In the large majority of cases, either the cæcum or the sigmoid flexure is the segment implicated. More rarely, the ascending or transverse colon. The writer has had to deal with the latter condition by resection in an umbilical hernia.

Cæcal volvulus. The cæcum is absent from its normal position; in more than half the cases it lies in the lower abdomen, but it has been met with beneath the mesentery, in the left flank, or in contact with the hepatic or splenic flexures of the colon. A long free mesentery to the cæcum, or cæcum and ascending colon, usually exists; in other cases the rotation appears to have been due to the overloading of acquired lateral pouches of the cæcum. Considerable distension of the cæcum is common, the contents being in great part gaseous. A preliminary temporary colotomy and evacuation of the contents allows the distended loop to be delivered more easily, and much facilitates the untwisting of the mesentery in a direction from left to right. In one case the writer was, in fact, unable to deliver the cæcum, which was impacted in the pelvis, until this measure had been undertaken. A firm palpable band is frequent, passing from below to the point in the ascending colon marking the distal extremity of the loop; this is formed by the mesocolon.

The rotation having been corrected, the cæcum should be fixed as nearly in its normal position as possible. In some instances this may be high, as the cæcum has never descended to its proper level, although provided with an abnormally long mesentery.

Fixation may be by a few sutures passing from the bowel itself to the abdominal wall, but if the mesentery is very long it is better to plicate this on its right aspect, or to stitch the mesentery to the parietal peritoneum. Corner and Sargent recommend plication of the cæcum itself in some cases.

Sigmoid volvulus. The distended coil may lie in any part of the abdomen, but most commonly it passes obliquely upwards and to the right. Its dimensions may be enormous. As in cæcal volvuli, evacuation of the contents is advisable prior to making an attempt to untwist the loop. When the bowel has been emptied the rotation necessary is easily effected, and the question arises as to what measures must be taken to prevent a recurrence.

Sigmoid volvulus is particularly the form in which chronic distension of the bowel and consequent great elongation of the loop take the main causative position. This chronic distension may depend on simple constipation; it may be a part of a general neurosis, as in hysterical subjects; or of a local condition due to some imperfection in the nerve-supply, as in the congenital dilatation of the colon. The chief measures which have been employed to prevent recurrence are fixation of the loop, lateral anastomosis at the base of the loop, and removal of the loop. Each and all have proved themselves unsatisfactory.

Fixation of the loop may be to the abdominal wall in the iliac region,

or an attempt to limit its mobility may be made by suturing the left aspect of the mesentery to the parietal peritoneum. Fixation of the loop to the abdominal wall does not suffice to prevent future distension; in one case of the writer's, a woman of fifty, in spite of this measure, the sigmoid flexure a year later was sufficiently distended to reach the liver, and obstruction again developed.

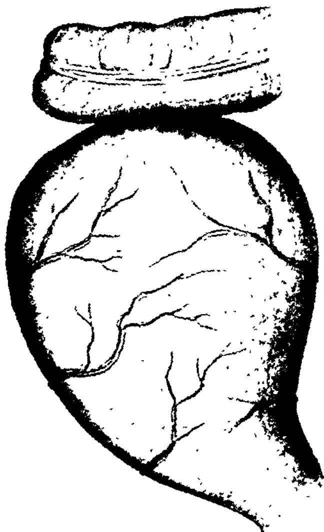


Fig. 238. Dilatation of the Distal Segment of the Pelvic Colon, subsequent to the Removal of the Sigmoid Flexure and Union by Lateral Approximation. The proximal segment retains its normal size, and the projecting closed end is unaltered.

Lateral anastomosis at the base of the loop is dangerous; in two cases of the writer's this was followed by recurrent torsion, once within a week, and once at the end of twelve months. In a third case, of megacolon in a boy of five, the anastomosis has been a success, the patient remaining well at the end of five years. Lastly, as to removal of the loop, the writer has twice performed this, once with success; in the second case dilatation of the distal segment slowly developed, a large sac being formed by the pelvic colon, which again gave rise to obstruction (see Fig. 238).

This experience shows that except in cases of recent sigmoid volvulus with a single loop, all existing modes of treatment are unsatisfactory. In fact, a simple colostomy and drainage of the dilated loop may be as satisfactory as any of the more radical methods when a large loop exists.

In cases of volvulus, whether of the large or small intestine, in which the general state of the patient or the local conditions are bad, resection of the loop combined with an enterostomy is indicated.

In connexion with sigmoid volvulus may be mentioned the condition in which a long sigmoid loop rises into the abdomen and the upper part again falls, compressing in the angle a coil, or coils, of small intestine. When possible, the loop should in such cases be resected.

What has been said above as to sigmoid volvulus applies with equal force to the treatment of obstruction due to congenital hypertrophic dilatation of the colon, but in these cases it must be borne in mind that a simple colostomy opening in the sigmoid colon may fail to act if the entire colon be involved in the condition.

Prognosis and results. The mortality after operations for volvulus is high, and highest in cases of volvulus of the small intestine. Of the 29 cases contained in the St. Thomas's series 19 died, a mortality of 65·5 %. The cases were distributed as follows: sigmoid flexure 9, cæcum 8, ascending colon 5, small intestine 7. The operations performed were—untwisting and fixation: sigmoid 7 with 2 deaths, cæcal 4 with 3 deaths, ascending colon 2 with 2 deaths, small intestine 5 with 5 deaths. Untwisting alone: cæcal 1, fatal; cæcoplication 1, recovery. Primary resection and reunion of bowel: sigmoid 1, small intestine 1; both recovered. Resection and enterostomy: cæcal 3, small intestine 1; all four fatal.

Corner and Sargent (*St. Thomas's Hospital Rep.*, 1903, vol. xxxii, p. 413) state that of 40 cases of cæcal volvulus collected by them, and in which operations were performed, 21 died, a mortality of 52·5 %.

OBSTRUCTION PRODUCED BY INTRAPERITONEAL ADHESIONS

Indications. Obstruction by the action of adhesions may be of the most acute form, especially when of the nature of a strangulation beneath a band. When the adhesions are of the broad form, or multiple, complete obstruction may only follow a period of variable length during which signs of chronic obstruction have been noticed.

A history of previous peritonitis, accompanying inflammation. of the gall-bladder, vermiform appendix, or the female generative organs; a history of tuberculous peritonitis, a severe attack of enteric fever, or the presence of an old hernial sac may aid in indicating the existence and also the locality of adhesions. In other cases similar information may be afforded by the presence of a scar in the abdominal wall, the result either of injury or a previous surgical operation.

The site of the adhesions may further be indicated in the early stages of obstruction by the position of the initial pain, the existence of localized tenderness and rigidity, and in conjunction with these signs evidence

of distension of a circumscribed length of bowel and increased local peristalsis.

Operation. The site of the incision in the abdominal wall is frequently indicated by the history, or local signs; in the absence of reliable evidence of this character, the paramedian subumbilical incision with displacement of the rectus muscle outwards should be chosen.

When the abdomen has been opened the search for the point of obstruction is governed by definite lines: (1) If the history or the local signs have indicated a special region this should be first explored. (2) If this be not the case, the pelvis should first be investigated in the hope of discovering a collapsed portion of the small bowel. If this be found, the gut is rapidly passed through the fingers, each length being replaced as a further is brought out until the source of obstruction is reached. (3) If the cæcum be distended, the sigmoid flexure is first sought, and should the latter prove collapsed, the incision must be prolonged somewhat, to give ample space for the introduction of the hand for exploration of the upper half of the abdomen and remaining segments of the colon.

The obstructing adhesion discovered, it is dealt with according to necessity.

Cord adhesions may pass between neighbouring coils, between coils and the solid viscera, between the gut and the mesentery, or between the intestine and the parietal peritoneum. They should be divided between two pairs of artery forceps, and then ligatured at the base, and any projecting free portion removed.

Broad adhesions are dealt with somewhat differently; if recent they are most suitably separated by gentle pressure with the fingers covered with a piece of gauze, and if there appears to be a chance of reabsorption it is well to separate any adhesions which come into view. When the adhesions are old and of firm cicatricial tissue, it is not advisable to separate more than appear to be necessary to relieve the obstruction. The actual process of separation involves risk to the integrity of the intestine, the knife or scissors often needing to be employed, and the bleeding from the torn surface may be difficult to control. Lastly, the raw surfaces are practically certain to acquire new connexions, probably with the development of two adhesions in the place of the one temporarily separated.

Difficulty in dealing with the adhesions may arise from the degree of distension of the bowels present. Under these circumstances the contents of the bowel should be evacuated by enterotomy (see p. 398). This procedure renders extensive evisceration unnecessary, and much diminishes the immediate risk of the operation. Pelvic adhesions often

give rise to the greatest manipulative trouble; considerable advantage in dealing with these may be gained by placing the patient in the Trendelenburg position.

In cases of very acute strangulation, or when the patient comes to the operating table at a late date, simple freeing of the adhesions may not suffice, since the bowel may already be gangrenous, under which circumstance an enterectomy may be necessary.

In other cases the condition may be too bad to allow of an enterectomy being undertaken, and an enterostomy must be performed. The artificial anus will usually be made at the seat of obstruction, but if there is reason to believe that the obstruction is not due to strangulation, and this is especially likely to be the case with recent inflammations, a temporary enterostomy above the seat of obstruction may be the safest procedure. An enterostomy serves to tide the patient over until the toxæmia secondary to the obstruction has been sufficiently removed to allow a more extensive procedure being performed with safety, and minimizes the risks of the immediate operation.

Multiple adhesions, especially such as are met with in tuberculous peritonitis, are often too extensive to be dealt with by separation, and the arrangements of the matted coils too intricate to allow a resection to be performed with safety. In such cases lateral entero-anastomosis is the most suitable method, and more than one intercommunication may be desirable. Entero-anastomosis is also the only resource in cases of adhesion of the intestine to inoperable morbid growths. A single knotted mass formed by intestine which has lain in an old hernial sac may, on the other hand, be resected with advantage.

Prognosis and results. In spite of the comparative simplicity of the operations for separation of adhesions, the form of obstruction due to this cause is a remarkably fatal one. That this in considerable measure depends on too tardy interference cannot be denied, but in many instances, particularly those dependent on internal strangulation, the degree of early toxæmia is striking. Of 102 cases of obstruction from adhesions treated by operation at St. Thomas's Hospital between 1888 and 1907, 64 died, a mortality of 62·7%. In 60 of the cases broad adhesions were the cause, with a mortality of 60%; in 42 band adhesions, with a mortality of 73·8%. The best results are obtained in internal strangulations attacked early, and in recent broad adhesions such as follow on operations, or develop in connexion with appendical abscesses. In the latter form early recurrence sometimes takes place. In any case in which numerous old adhesions exist, recurrence of the trouble at some future date is not uncommon, and such attacks of obstruction may be many times repeated.

OBSTRUCTION BY ADHERENT VERMIFORM APPENDIX

This is not very uncommon; it partakes in one character with the form next to be described, *viz.* that a double source of danger may exist in gangrene of the constricting tube as well as of the constricted portion of intestine. This danger is, however, in some cases eliminated by the fact that the constricting appendix has previously undergone a process of obliteration; *while in others, either only a cicatricial band passing* from the tip of the appendix is concerned in the strangulation, or the



FIG. 239. STRANGULATION OF A LOOP OF INTESTINE BY A VERMIFORM APPENDIX. The tip of the appendix is adherent to the mesentery at the site of a softened mesenteric gland. H. B. Robinson's case. (*St. Thomas's Hospital Museum*, No. 1287A.)

band causes obstruction by tension and kinking, and not by encircling the affected portion of intestine.

Operation. The operative treatment differs from that of cicatricial bands only in the fact that removal of the appendix by the *ordinary method should form a part of the operation for the relief of* the obstruction.

OBSTRUCTION BY AN ADHERENT MECKEL'S DIVERTICULUM

This persistent remnant of the omphalo-mesenteric duct is found in some 2% of all subjects, but much more frequently in male subjects (86–14, Hilgenreiner).

Indications. Half the patients are children or young adults

under twenty years of age, but obstruction from this cause is met with much later. A history of previous temporary attacks of obstruction often exists; this is probably particularly the case when the diverticulum itself is the strangulating agent and not a band passing from it, since the diverticulum forms a comparatively soft and broad constricting ring, and the engaged intestine may escape with changes in the position of the patient and of the abdominal contents. For the same reason the



FIG. 240 STRANGULATION BY A MECKEL'S DIVERTICULUM. A group of coils of small intestine encircled and strangulated by a Meckel's diverticulum, the distal end of which is attached to the mesentery. (*St. Thomas's Hospital Museum*, No. 1282.)

symptoms of obstruction may be comparatively mild. When the patient is seen early local distension and peristalsis may be detected, and local tenderness just above McBurney's point may be elicited. In a considerable number of instances an abnormal degree of scarring at the umbilicus exists.

Operation. A paramedian subumbilical incision, with outward displacement of the rectus, is the best, since the point of origin of the diverticulum from the ileum is usually within thirty inches of the ileocolic valve.

In carrying out the exploration several points should be kept in

mind. (1) The probable seat of origin of the diverticulum. (2) The position of its distal attachment. This is most frequently to the mesentery, somewhat less so to the umbilical cicatrix, and rarely to the intestine. With a mesenteric attachment the strangulated coil may lie deeply; when the attachment is to the intestine the obstruction may be due to kinking. (3) The varieties of arrangement which may be present. Thus, the tube varies in length from 2 to 4 to 8 inches; its calibre may equal that of the ileum itself, or be small or irregular. A mesentery may be present; this may be complete with a thick fibrous margin, representing the original omphalo-mesenteric artery. In other instances the mesenteric fold atrophies and disappears, leaving the fibrous cord unattached to the diverticulum, but retaining its original position; or both mesentery and tube may have disappeared, leaving the vestigial fibrous cord alone. (4) The nature of the obstruction is not in all cases a strangulation; in a minor proportion of instances tension by the diverticulum may produce kinking and valvular obstruction of the bowel, while tension, invagination, prolapse, and secondary stenosis of the intestine have all been observed. (5) In some instances signs of obstruction appear to develop secondarily to an acute inflammation of the diverticulum resembling the corresponding condition of appendicitis.

Examination of the lower end of the ileum and the umbilical region of the anterior abdominal wall is the first step in the exploration; if the search here proves unsatisfactory, a certain degree of evisceration may be necessary to expose the seat of obstruction. When the diverticulum has been localized it is usually necessary to separate one extremity, preferably the distal, in order to free the strangulated bowel. If this attachment be to the umbilicus, the same precautions must be taken as if the bowel required to be opened, since a lumen may exist up to the actual point of termination. When the obstructing agent is formed by the band already alluded to, simple division between clamp forceps suffices.

The distal attachment freed, the engaged bowel is examined, and if in good condition replaced. The coil of intestine from which the diverticulum springs is then drawn out of the belly and clamps are applied, either a proximal and distal one, or, where a long mesentery exists, one long clamp may be applied across the base of the loop. The cavity and margins of the abdominal wound are protected by plugs and the diverticulum removed.

Removal is best effected by the application of Kocher's crushing clamp to the base, as in removing an appendix. The resulting stump is ligatured, and sunk by the introduction of a continuous Lembert's or mattress suture, passed in the transverse axis of the bowel. If the clamp

be not to hand, the base, if small, may be crushed with an artery forceps and similarly treated.

When the diverticulum is inflamed and stiffened, the clamp method is inapplicable, and it is preferable to incise the serous and muscular coats and raise them either as a circular cuff or in two flaps. The mucous membrane is then ligatured, and the defect sutured as above described. Should the condition of the mucous membrane, or the width of the base of the diverticulum, preclude the use of the ligature, the opening must be closed by two tiers of sutures passed in the transverse axis of the bowel.

Complications in the performance of the operation may depend either on the condition of the bowel or of the diverticulum itself. Strangulation may have resulted in gangrene of the included loop; in this case an enterectomy will be indicated, unless the general condition of the patient should be such that the performance of a temporary enterostomy alone can be entertained. If the condition has commenced with, or resulted in, inflammation of the diverticulum itself, the latter may readily tear and give exit to highly infective material, or a condition of gangrenous cellulitis may have extended to the ileum. The latter condition may demand an extensive resection such as is occasionally required in cases of gangrenous hernia.

Prognosis and results. The prognosis depends upon the date at which the operation is undertaken, and upon the nature of the obstruction. The chief cause of mortality is peritoneal infection, which in cases of strangulation or inflammatory conditions may have already developed on the second or third day. The local complications already alluded to also obviously depend on the flux of time, and operation is not to be held responsible for deaths from such causes. Of twenty-two operations performed at St. Thomas's Hospital between 1887 and 1908, eight were successful, a mortality of 63 6% occurring, which is 1% higher than that observed in all the cases of obstruction, excluding malignant cases and external hernia. In Hilgenreiner's (*Beit. z. klin. Chir.*, 1902, vol. xxxiii, p. 177; also vol. xl, p. 69) 102 collected cases the mortality amounted to 71·5%.

Strangulation by the Fallopian tube, or by a long pedicle of an ovarian cyst, has been occasionally observed. The portion of intestine included may be small gut, as in Fagge's case, or the sigmoid flexure. In the latter instance isolated distension of the loop may give rise to a diagnosis of sigmoid volvulus. In such a case of the author's the cyst, having risen into the abdomen from the left ovary, crossed the base of the sigmoid flexure from right to left, and descended into the pelvis, where it became impacted. The first step consisted in

enterotomy for evacuation of the contents of the sigmoid, followed by puncture of the cyst; the latter was readily lifted from the pelvis, the intestine freed, and the emptied cyst was then removed.

Intestinal obstruction due to the presence of ovarian tumours is much more commonly the result of intestinal adhesion to cysts which have become inflamed or of which the pedicle has undergone torsion.

OBSTRUCTION DUE TO STRANGULATION IN ABNORMAL OPENINGS IN THE MESENTERY, OMENTUM, AND BROAD LIGAMENTS

Indications. These forms of obstruction are rare, and the indications for operative treatment are usually signs of an acute nature calling for abdominal exploration.

Operation. *Apertures in the mesentery* are discovered by abdominal exploration, and the treatment consists in delivering the bowel and closing the adventitious opening. Should the constricting margin require incision, the latter should be radial in the course of the main vessels. Experience has shown that the constriction in these cases is usually not very severe in character. Thus, in Stabb's case (*St. Thomas's Hospital Reports*, 1891, vol. xxi, p. 174) two separate loops of intestine, one 5 inches long, and a second 10 inches long, situated 30 and 64 inches from the ileo-colic valve respectively, were readily withdrawn from the circular opening in the mesentery. The strangulated bowel and corresponding mesentery were only slightly nipped, in spite of the fact that the symptoms had been very acute. In Howard Marsh's case (*Brit. Med. Journ.*, 1888, vol. 1, p. 1157) again, the intestine was released after stretching the yielding margin of the ring with the finger-nail.

Apertures in the omentum, either traumatic or developed in connexion with disease of the omentum, may give rise to strangulation, but their treatment calls for no special attention.

Apertures in the broad ligament are rare sites of strangulation. In the cases described, a similar slight degree of constriction to that observed with mesenteric apertures has been noted.

Prognosis and results. During the twenty years ending with 1907, 5 cases of strangulation in mesenteric apertures, 4 in the classic situation near the ileo-colic junction, and 1 secondary to tuberculous disease in the transverse mesocolon, were admitted into St. Thomas's Hospital. Of these 1 died before operation could be undertaken; the other 4 succumbed after operation, 1 needing resection of gangrenous gut. Prutz ('Die angebornen Lücken und Spalten des Mesenteriums,' *Deutsche Zeitsch. f. Chir.*, 1907, vol. lxxxvi, p. 399) has collected 18 cases treated by operation, of which 13 died (72·2 %). Of 6 cases of strangulation in broad-ligament gaps collected by Wilms (*loc. cit.*, p. 362) 1 only recovered.

HERNIA INTO THE RETROPERITONEAL POUCHES

From an operative point of view these herniæ may be divided into two series, an upper and a lower. The first group includes hernia through the foramen of Winslow and the various fossæ in the region of the duodenum and root of the mesentery; the second group, those into the fossæ around the cæcum, the intersigmoid, and the rare hernia into Douglas's pouch.

Upper series. These herniæ possess some special features in common: they are commonly large; they belong to the category in which recurring temporary attacks of obstruction are not rare; they give rise to somewhat characteristic localized distensions of the abdomen in the upper and central areas, and they are to be explored when diagnosed or suspected by an incision giving access to the epigastric and umbilical regions.

The indications for operation are those of acute obstruction of the small intestine, although in the herniæ into the foramen of Winslow the colon may be affected.

Herniæ into the lesser sac of the peritoneum. The most common form is that in which the neck of the sac is formed by the foramen of Winslow. The contents consist most frequently of coils of small intestine, but both small and large intestine have been included, also large intestine alone. The contents of the hernia may be confined to the normal limits of the sac, or they may extend into unobliterated portions of the spaces between the layers of the gastro-hepatic or gastro-colic omenta, or even secondarily penetrate one of these layers from within to re-enter the main peritoneal cavity.

Operation. In the exploration of a hernia through the foramen of Winslow, if the nature of the case be suspected, a paramedian supra-umbilical incision through the right rectus sheath with displacement of the muscle outwards will be the most suitable.

The points which will need consideration during the prosecution of the operation are the following:—

1. The neck of the hernia is first to be explored; this is at the right extremity of the sac, and the distension present will mainly affect the part of the intestine contained within the sac. It may be found that the contained intestine can be withdrawn without much difficulty; in this case the obstruction may have depended on twisting of some of the coils within the sac, or it may be found to depend on a second constriction at a point in the walls of the omental sac where the contents have made a secondary exit.

2. When the large intestine is included, it has been pointed out by

enterotomy for evacuation of the contents of the sigmoid, followed by puncture of the cyst; the latter was readily lifted from the pelvis, the intestine freed, and the emptied cyst was then removed.

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Apertures in the omentum, either traumatic or developed in connexion with disease of the omentum, may give rise to strangulation, but their treatment calls for no special attention.

Apertures in the broad ligament are rare sites of strangulation. In the cases described, a similar slight degree of constriction to that observed with mesenteric apertures has been noted.

Prognosis and results. During the twenty years ending with 1907, 5 cases of strangulation in mesenteric apertures, 4 in the classic situation near the ileo-colic junction, and 1 secondary to tuberculous disease in the transverse mesocolon, were admitted into St. Thomas's Hospital. Of these 1 died before operation could be undertaken; the other 4 succumbed after operation, 1 needing resection of gangrenous gut. Prutz ('Die angebornen Lücken und Spalten des Mesenteriums,' *Deutsche Zeitsch. f. Chir.*, 1907, vol. lxxxvi, p. 399) has collected 18 cases treated by operation, of which 13 died (72·2 %). Of 6 cases of strangulation in broad-ligament gaps collected by Wilms (*loc. cit.*, p. 362) 1 only recovered.

tumour; and possibly the presence of hæmorrhoids, and the passage of blood *per anum*; the last symptoms resulting from obstruction and pressure at the neck of the hernia on the inferior mesentéric vein.

If the hernia be suspected to be into one of the duodenal pouches a paramedian incision is that most likely to be convenient, and as left

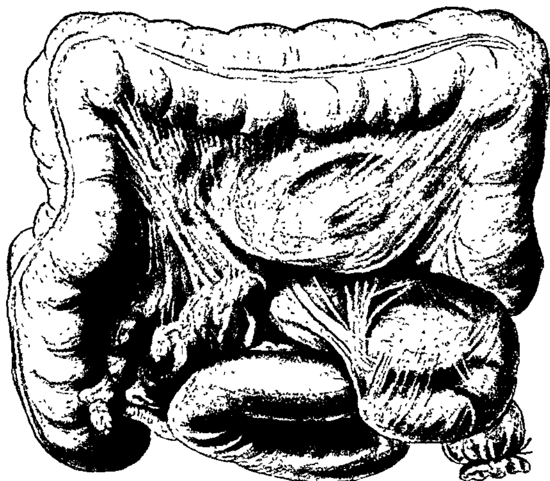


FIG. 241. SMALL LEFT DUODENAL HERNIA. The highest coils of the jejunum are in the sac. The vessels are seen in the neck of the latter. Shattock's case. (*St. Thomas's Hospital Museum*, No. 1279.)

duodenal hernia is the most common variety, the incision should be as a rule made through the left rectus sheath.

The size of such herniæ varies enormously; the contents may consist in a single short coil of intestine, or nearly the whole small intestine may be included. As a rule the cases subjected to operation have been of the larger class, and these are perhaps prognostically the relatively favourable, since in small herniæ the strangulation is apt to be the more acute (see Fig. 241). In the large herniæ the appearance on exploring the abdomen is very striking, since nearly the whole small intestine may be hidden from

Moynihan that this depends on abnormal mobility of the cæcum, and possibly of the ascending colon due to the presence of a 'common mesentery'. Under these circumstances it may be well to attempt to try and limit this mobility by fixing the cæcum into its proper position by the introduction of sutures between its base and the abdominal wall, or by pleating its mesentery, since an effectual closure of the peritoneal clad ring cannot be made.

3. When difficulty arises in the extraction of the contained bowel, the first step should be the evacuation by enterotomy of its contents, since the strangulated intestine can be readily reached by tearing through the thin omental wall in a convenient position. This will much facilitate subsequent procedures. In Delkeskamp's case the evacuation was effected by merely pressing the contents of the incarcerated cæcum and ascending colon onwards through the hepatic flexure, when the bowel was readily drawn out of the foramen.

The extraction of the bowel has, however, proved impossible, as in the classical case of Treves, where even after death the bowel could not be drawn out until the portal vein, hepatic artery, and the bile duct had been divided. It has been suggested by Moynihan and Wilms (*loc. cit.*, p. 384) that the constricting neck may be enlarged by division of the peritoneum as it passes from the duodenum to the posterior abdominal wall, the incision being carried up to the lower margin of the foramen. This mobilizes the duodenum, and allows of its displacement downwards with some enlargement of the ring.

4. Other forms of hernia into the omental sac need no special measures, the constricting ring formed by the omentum being thin and easily stretched or divided without danger of injury to any important structures.

Hernia of the duodeno-jejunal, parajejunal, and retromesenteric varieties. The most important forms are those which have been conveniently classed by Moynihan under the names of right and left duodenal hernia. For these, a sufficient number of observations have been collected by Moynihan to allow of some definite lines being laid down for operative treatment; the rarer varieties need to be dealt with as the conditions discovered at the moment may suggest.

Left duodenal hernia (hernia into the duodeno-jejunal fossa). A correct diagnosis of the nature of the obstruction in strangulations in the duodeno-jejunal fossa is sometimes possible if the indications first laid down by Leichtenstern be borne in mind. Thus, the presence of a globular swelling in the mesogastrium; hollowness in the colic area; in thin patients, the detection on palpation of a circumscribed elastic tense globular tumour resembling a large slightly movable cyst extending from the mesogastrium to the left; a sonorous percussion note over the

more individual coils may escape from the sac, and again enter the peritoneal cavity. The strangulation may then involve one of such coils and not the main contents of the sac.

In many cases reduction is easy; if this be not the case, the neck of the sac must be cautiously divided at its lower margin, care being exercised to avoid injury to the inferior mesenteric vein or left colic artery. When difficulty is met with, the parietal peritoneum and the anterior wall of the sac itself should be incised, and the intestine drawn forward and emptied. Removal of the sac is usually impracticable, but an attempt to close the neck by suture should be made. Bearing in mind the mode of development of these herniæ, any possibility of re-formation would probably be effected by a limited fixation of the jejunum to the wall of the abdomen, to the left of the inferior mesenteric vein. Sherren (*Clin. Soc. Trans.*, 1906, vol. xxxix, p. 99) reports a successful case of operation. The vessels occupied the upper and left border of the neck for a short distance only. He divided the neck downwards, removed as much as possible of the peritoneal reduplication, and sutured the edges with catgut.

Right duodenal hernia. In general characteristics this hernia closely resembles the last, except in the fact that the body of the sac and its neck occupy the right half of the abdominal cavity, the sac only spreading to the left when it assumes large proportions. The right variety has not been so often observed; thus Moynihan was only able to collect 17 cases, against 57 of left duodenal hernia.

Operations for the relief of strangulation are to be conducted on the same lines as in left duodenal hernia, but it must be remembered that the sac itself often occupies a lower position in the abdomen, that the neck is at the left end of the sac, but situated to the right of the vertebral column, and that the superior mesenteric artery takes the place of the inferior mesenteric vein in the anterior boundary of the neck. The wandering of the neck of these herniæ appears to be responsible for some of the rare varieties of retromesenteric hernia which have been observed.

Lower series. The herniæ of this series, when strangulated, are commonly to be diagnosed only by abdominal exploration, the indications for operation being symptoms of acute obstruction of unknown cause. The most convenient site for the exploratory incision is sub-umbilical through the right rectus sheath, since an opening in this position gives access to all the varieties.

The cæcal region is first to be explored, as the very large majority of the herniæ are to be found here (see Fig. 243). Intersigmoid hernia has only been certainly observed on two occasions (Eve, McAdam Eccles),

view. In extreme cases the peritoneum of the mesenteries of the descending and transverse portions of the colon may have been so drawn upon in the development of the sac, that these portions of the large bowel are as it were spread out upon its surface.

In left duodenal hernia the neck lies to the right of the sac, and is situated to the left of the third lumbar vertebra. If the hernia be small the opening retains the normal direction of the mouth of the fossa, looking forwards and to the right. As the hernia increases in size the opening tends to rotate backwards, looking first directly to the right, then directly backwards. In this case it will be necessary for exposure of the neck to drag the sac over towards the left.

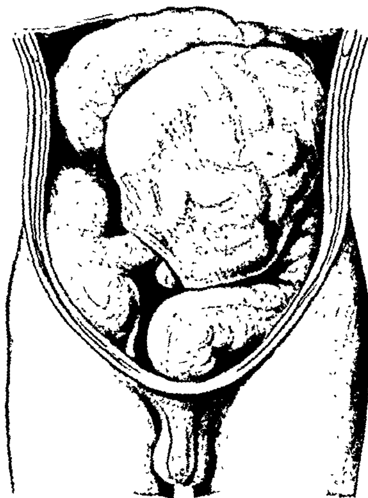


FIG. 242. LARGE DUODENAL HERNIA. Escape of a single limb of the bowel (*Aschoff.*)

The size of the opening does not always correspond with that of the hernia, and may in fact vary inversely, being large with a small sac. The neck is bounded anteriorly by the fold containing the inferior mesenteric vein, and possibly the left colic artery; the posterior boundary is formed by the posterior parietal peritoneum.

Certain peculiarities of this hernia are to be borne in mind: (1) as a result of the mode of the formation of the neck, the duodeno-jejunal junction may be enclosed within the sac, so that the emerging intestine only is seen (see Fig. 242), (2) the upper portion of the contents may have escaped, leaving perhaps only ileum in the sac, in which event both the entering and emerging limbs will be seen, (3) in large herniæ one or

Strictures of the jejunum and ileum may be situated in any part and are sometimes multiple. Ileal strictures may be associated with a persistent Meckel's diverticulum. In the large intestine the ascending colon and the sigmoid flexure are the most common seats.

The condition to be dealt with varies. In the small intestine there may be a complete absence of continuity, the proximal and distal segments may be connected by a fibrous cord, the connecting cord may possess a minute lumen, or the gut may be completely occluded by annular constrictions. In the colon either a thin septum or a complete interruption of continuity is the more common form.

Operation. The possibility of an enterectomy seldom exists, not only on account of the tender age and general condition of the infants, but also on account of the disparity in size between the upper and lower segments of the bowel.

For the high duodenal stenoses a gastro-enterostomy is indicated. In the low duodenal stenoses the dilated duodenum may be connected with the jejunum, the latter being brought through the transverse mesocolon. Murphy advises that the jejunum be divided for this purpose, the free end closed, and a lateral anastomosis made.

For most strictures in a lower position an enterostomy is the only immediate resource, the opening being utilized for purposes of nourishment pending the later establishment of an anastomosis.

Results. The recorded results have not been of an encouraging nature; thus of 25 infants on whom operations have been performed (19 enterostomies, 4 anastomoses) not one recovered (Braun, *Beitr. z. klin. Chir.*, 1902, vol. xxxiv, p. 993).

Acquired stenoses. These may be the consequence of injury, and are then commonly complicated by the coexistence of adhesions. Circular stenoses may develop at the site of a hernial constriction of the gut, at the neck of an intussusception which has sloughed away, or follow an axial enterectomy. In other instances the stricture may follow disease of the wall of the bowel; thus, the cicatrization of stercoral ulcers, the ulceration of enteric fever or dysentery, or tuberculous or gummatous infiltration. Strictures resulting from tuberculous or enteric ulceration are usually situated in the ileum.

Operation. The ideal treatment in cases of stricture consists in some form of enteroplasty, but this is only applicable to cases in which at least a half of the natural lumen persists, and in the localized annular forms.

The simplest and most satisfactory procedure consists in making an incision in the long axis of the bowel at the antemesenteric margin, 1 to 1½ inches in length.

and the hernia through a diaphragm occupying the entry to Douglas's pouch once (Saniter).

Release of the strangulated portion of bowel is usually easy, and the neck of the sac should be *obliterated by suture, if practicable*. In herniæ into the ileo-appendicular fossa (the hollow between the ileo-appendicular fold and the mesentery of the vermiform appendix), removal of the appendix serves to completely remove the fossa (Moynihan).



FIG. 243 TWO RETROCÆCAL POUCHES ASCENDING BEHIND THE COLON. The vermiform appendix lies in the lower pouch. (*St. Thomas's Hospital Museum*, No. 1281.)

Prognosis and results. Operations in these forms of obstruction are rare. Moynihan mentions five operations for herniæ through the foramen of Winslow with two recoveries. In one fatal (Treves), and in one successful case (Neve), reduction proved impossible. Eight cases of herniæ in the fossa in the neighbourhood of the cæcum with four recoveries, and one successful operation on an intersigmoid hernia (McAdam Eccles), are also recorded by him.

A wealth of information on the subject of these herniæ is contained in Moynihan's work (*On Retroperitoneal Herniæ*, Second Edition, 1906) on the subject, to which the writer has been mainly indebted in the compilation of this short section.

STRICTURES OF THE INTESTINES

Strictures of the intestine may be congenital or acquired, and are met with in all parts of the intestinal canal.

Congenital stenoses. Of 89 cases collated by Schlegel (Wilms, *loc. cit.*, p. 140), 29 or 32·5% were duodenal, 54 or 60 6% jejuno-ileal, and 6 or 6 6% colic.

Duodenal stenoses are more common above the level of the papilla of Vater; the signs then resemble those of pyloric obstruction; when the stricture is situated below the papilla the vomit contains bile and pancreatic ferments.

the ascending colon, 2 in the sigmoid colon, and the fourth in the upper part of the rectum. Sargent has collected (*Ann. of Surg.*, 1904, vol. xxxix, p. 733) 18 cases of cicatricial stricture consequent on strangulation of the intestine in hernial sacs. On 11 of these operations were performed, 4 dying, a mortality of 36·3 %. Three enterectomies recovered, also an enterostomy followed by anastomosis. Two enteroplasties were successful, and one of two lateral anastomoses. Three enterostomies were followed by death.

The bad prognosis experienced in the treatment of stenoses depends on the fact that premonitory symptoms of chronic obstruction have been overlooked or remained untreated, since the surgical treatment of a cicatricial stricture is in itself unattended by serious difficulty or danger.

OBSTRUCTION BY BILIARY OR INTESTINAL CALCULI

Intestinal calculi are rare ; they occur twice as frequently in men as in women.

Obstruction by biliary calculi is more common, the stone passing either by the duct, or by ulceration from the duct into the duodenum, transverse colon, or, rarely, the stomach. Those that pass into the colon seldom give trouble, but several cases of sigmoid obstruction are on record, and occasionally stones may be retained near the anus for some time. Large stones entering the duodenum more often give rise to intestinal obstruction.

Indications. The occurrence of obstruction is sometimes preceded by a history of gall-stone colic, but this may be absent. The attack presents peculiar features due to the fact that the source of obstruction is of a shifting nature. Initial pain is followed by free vomiting, which may entirely evacuate the contents of the alimentary canal above the impacted calculus. This feature, together with the fact that the primary obstruction is high, renders distension of the abdomen uncommon. A remission of the primary symptoms may therefore occur, followed by a recurrence when the progress of the moving stone again ceases. The arrest of the stone may give rise to considerable enterospasm, or even be followed by a moderate degree of intussusception. The symptoms are accompanied by resistance in the lower abdomen, sometimes localized to the right iliac fossa, and the absence of distension occasionally allows the stone to be actually palpated.

Operation. A right paramedian subumbilical incision with outward displacement of the rectus is most suitable. Search for the stone is commenced by examination of the lower ileum, the most common point of arrest. If the termination of the ileum be collapsed, the bowel is rapidly searched in an upward direction In this particular, however, it should

A single mattress suture is passed through the bowel-wall in such a manner as to include the two ends of the incision. Traction on this stitch allows the two angles to be approximated at a point which corresponds with the centre of the subsequent transverse line of suture. The coaptation stitch may be tied loosely with a surgical knot, and the transverse suture is commenced from above downwards. The latter should be continuous, and carried through all the coats of the intestine; when complete the coaptation stitch may be removed, and the whole line of suture sunk by the introduction of a second tier of continuous Lembert's stitches (see Fig. 244).

Conditions such as the presence of external adhesions, neighbouring diseased tissue, the implication of a considerable length of the bowel-wall, or the presence of multiple stenoses, frequently contra-indicate a simple enteroplasty. Under these circumstances, resort must be had either to lateral anastomosis or enterectomy. When the stricture is single, an enterectomy is preferable; when the stenoses are multiple, the obstruction is best relieved by the establishment of a lateral anastomosis. In such cases as those due to tuberculous disease, more than one anastomosis may be required (see p. 475).

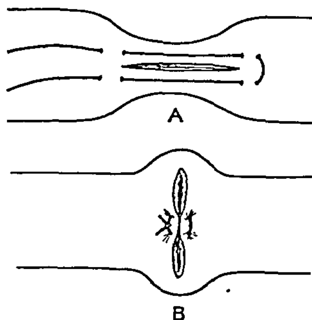


Fig. 244. Introduction of a Coaptation Mattress Stitch in Simple Enteroplasty.

Enterostomy comes under consideration as a temporary measure only in those instances in which the general state of the patient is bad, or the local condition of the intestine forbids for the moment any more satisfactory procedure.

Prognosis and results. The prognosis in cases subjected to either enteroplasty, enterectomy, or anastomosis should be good, but many patients come into the hands of the surgeon having already developed serious complications. This is well illustrated by the series of 9 cases included in the St. Thomas's table, of which only 1 recovered. Five were strictures of the small intestine, of which all died. In 3 of the fatal cases the operation was indicated by peritoneal infection resulting from spontaneous perforation. The remaining 4 cases were situated, 1 in

Results. The results of operations for the removal of gall-stones are steadily improving, and the mortality of 40% will no doubt be materially reduced as operations are more generally undertaken at an early date.

FÆCAL IMPACTION

The simple retention of fæces may sometimes give rise to complete intestinal obstruction, but it is rare that the condition calls for surgical measures, apart from the cases in which the impaction is due to the obstruction of a narrowed portion of the bowel by a mass of hardened fæces.

The condition is most frequently met with in patients afflicted with general enteroptosis, the subjects of severe chronic constipation, the old, or the feeble-minded.

When the obstruction is complete, is accompanied by vomiting, and has proved resistant to every other means, an abdominal exploration may become necessary. Two methods of treatment then exist. The obstruction may be found to depend on the impaction of separate hardened masses, especially in the sigmoid flexure, which by manipulation may be passed downwards in the colon. If this method fails, a temporary colostomy must be established.

be borne in mind that the stone is readily felt, and the introduction of the hand into the abdomen usually allows of its localization at once, which may save considerable unnecessary manipulation of the bowel.

Certain other possibilities are to be borne in mind with regard to the point of arrest. This may be determined by the presence of local adhesions of the external surface of the bowel, or by the existence of a stenosis. Thus, in a case of tuberculous disease Mayo Robson found a gall-stone above a stenosed portion of the bowel. Again, the stone may be impacted on the proximal side of a hernia, or indeed within the confines of the hernial sac itself.

When the stone has been localized it should be passed backwards from the point at which it has been arrested, to avoid incising the bowel at a damaged spot, and the coil of gut containing it is drawn well out of the abdomen.

A long retaining clamp is applied to the base of the coil, or a small clamp is applied on either side of the stone, and the peritoneal cavity and the wound in the abdominal wall are protected by the insertion of gauze plugs. A longitudinal incision is made in the wall of the bowel at the antemesenteric aspect of sufficient extent to allow the stone to be expressed. The wound in the bowel is closed by two rows of sutures, an inner through and through, and an outer of continuous Lembert's or a series of mattress stitches. If the incision be of moderate length it is best united in the transverse axis of the bowel. The exposed coil is now thoroughly cleansed, the retaining clamp and the gauze plugs are removed, and it is returned into the abdomen.

In some cases it may prove easy to pass the stone onwards into the colon, and if this is the case, and the bowel-wall is in good condition, it is the best plan to adopt.

When the stone has been removed it may exhibit one or more facets, suggesting the existence of a second calculus. Under these circumstances the surgeon should satisfy himself that a second stone is not concerned in the production of obstructive symptoms, but a too exhaustive search in the region of the gall-bladder is undesirable, since by it adhesions between the gall-bladder and the bowel may be disturbed, leading to leakage and consequent peritonitis

The occurrence of a period of latency in the symptoms is responsible for a certain proportion of these cases coming under the notice of the surgeon at a late date ; hence, the intestine in the neighbourhood of the stone may have become gangrenous. An enterectomy is then indicated, or if the condition of the patient forbids this, an enterostomy must be established. This eventuality, in the case of the small intestine, is naturally to be avoided if possible.

exists as to the nature and situation of the latter, the paramedian subumbilical incision should be chosen for the exploration.

The locality of the primary lesion should, if possible, be first determined. If it be practicable to deal with this in such a manner as to prevent any further supply of infective material, as by the suture of a wound or perforation, or sometimes by the removal of an inflamed organ, as a suppurating Fallopian tube or an infected ovarian cyst, this step should form an integral part of the operation. It is rare for a case of diffuse peritoneal infection to terminate favourably when the surgeon remains in ignorance of the initial origin of the condition ; still, the state of the patient may preclude any more extensive procedure than the mere evacuation of the peritoneal effusion and the establishment of drainage, and this defective operation is preferable to the maintenance of a purely expectant attitude, since a recovery occasionally follows.

Methods of dealing with the effusion. The mere act of opening the peritoneal cavity allows the escape of a considerable amount of fluid in some cases, which may be supplemented by the introduction of a syphon tube if desired. Further steps are guided by definite rules, the essential spirit of which is the occasionment of as little disturbance of, and damage to, the peritoneum as possible. In the removal of effusion, all possible delicacy of manipulation is to be observed; the fluid should be literally *absorbed* by the introduction of soft dry sterile gauze strips into cavities made by gentle displacement of the intestine. No *scrubbing* is allowable, since this both favours immediate absorption and increase in toxæmia, and the formation of ulterior adhesions. Care should be at the same time exercised to avoid favouring absorption by the exposed tissues of the wound in the abdominal wall, which should be protected as far as possible by holding forward the margins of the peritoneum and the application of a gauze covering during the intraperitoneal manipulations.

When the infection is quite recent, the fluid consists mainly of reactionary peritoneal effusion, which should be absorbed by sterile swabs with as little disturbance of the contents of the abdomen as possible. If it be due to a perforation of the stomach or duodenum, escaped contents of the viscera require to be removed, and this process may need somewhat widespread examination of the hepato-renal pouch and the under surface of the diaphragm. In such cases reactionary peritoneal effusion has usually gravitated into the pelvis, either over the great omentum, or along the course of the ascending colon, according to the position of the primary lesion. If this be the case it is usually perfectly safe, when the perforation is not of more than twenty-four hours' standing, to neglect the intervening portion of the abdominal

CHAPTER XIV

GENERAL LINES OF TREATMENT OF DIFFUSE PERITONEAL INFECTION

DIFFUSE peritoneal infection may rarely be of hæmatogenous origin; occasionally it results from the entry of organisms by the Fallopian tube; in other instances the infection results from the migration of organisms through an intestinal wall, the vitality of which is lowered by acute distension usually accompanied by an increase of toxicity of the contents of the bowel; but as affecting surgical treatment its genesis is more common in connexion with a gross perforation of some portion of the gastro-intestinal canal than from any other cause. Certain definite lines should guide the technical treatment of the condition, with minor variations depending upon the stage to which the process has attained, the nature and situation of the occasioning primary lesion, and the variety of the organism concerned.

Indications. It may be broadly laid down that cases of acute diffuse peritoneal infection accompanied by effusion demand prompt surgical intervention, the objects of the aid afforded being the relief of the mechanical tension which favours absorption, and the provision of a free channel of exit for the infective material from the peritoneal cavity.

Need for some discrimination in the application of this indication is obvious, and very great difficulty may arise in arriving at a correct decision if more than thirty-six hours have been allowed to elapse after the occurrence of the initial infection. Exceptions to the rule may be made: (1) When the incidence is accompanied by so severe a degree of shock as to render the increase likely to follow an operation prohibitive of success, especially when the infection is in the region of the gall-bladder or in the lower abdomen. (2) When the condition has been allowed to remain untreated beyond a period of forty-eight hours, and any signs indicating localization are developing.

Operation. For some details as to the preliminary preparation of the patient for these operations, reference may be made to p. 518. The site of the primary incision will in some cases be determined by a previous diagnosis of the seat of the occasioning lesion; if doubt

deprecated, since to the objections already raised to the process of flushing must be added great increase of shock, increase of distension of the exposed coils, and a definite lowering of their vitality.

Peritoneal Drainage. In early peritoneal infections, such as those met with in perforations of less than twenty-four hours' standing, drainage may be dispensed with, provided the initial lesion has been satisfactorily dealt with. Under these circumstances the peritoneum is perfectly capable of dealing with the degree of infection which has already taken place. When actual suppuration has developed drainage is desirable.

The question then arises whether drainage from a single opening or the introduction of several tubes after multiple incisions of the abdominal wall is indicated. Generally speaking, a single drainage aperture at a dependent spot is to be preferred if adhesions are not present.

It is to be remembered that the efficient action of a peritoneal drain is seldom continued beyond a period of twenty-four hours ; again, that if adhesions are not already present, the immediate effusion tends to gravitate towards the pelvis if the patient be placed in a suitable position. The passage of any but strictly local effusion by a drainage tube ceases at a period corresponding to that at which gravitation of the general effusion also ceases to continue. Hence the action of a drainage tube, except as a purely local matter, is of short duration and utility.

Any advantage to be gained by the use of multiple incisions is therefore highly doubtful, and they should only be employed when large irregular localized collections are met with. Thus, while the advantage of separate drainage of the two iliac fossæ in appendical infections crossing by the pelvic route, or where the effusion is more or less localized in both loins, cannot be denied, yet, in general infections unaccompanied by the presence of adhesions, a single tube inserted deeply into the pelvis is much to be preferred to multiple incisions with a series of tubes emerging from the flanks and loins.

The most effective drainage is obtained by the use of large-sized rubber tubes, but when it is desired to maintain a free opening for more than twenty-four hours, it is well to supplement the tube by the passage of a gauze plug by its side ; or, where two tubes are inserted in different directions from the same opening, by the introduction of a gauze plug between them so as to preserve a temporary potential space. The plugs are of use as acting by capillarity, and still more by maintaining a sufficiently free separation of the margins of the abdominal wound, which tend to rapidly contract around a simple tube. It is to be constantly borne in mind that the presence of a drain involves the formation of surrounding adhesions, hence the large gauze tampons formerly used freely are to be avoided. The employment of such large plugs, inserted for instance into

cavity and simply remove the fluid which has collected in the pelvis from a second hypogastric incision.

When the infection is of longer standing the difficulties may be greatly increased by the addition of peritoneal adhesions, and the fact that a part of the effusion will be much more highly infective than the remainder. When this is the case, it is preferable, if possible, to first absorb the peripheral less highly infective portion of the effusion and then protect the general peritoneal cavity with plugs before dealing with the area immediately surrounding the primary lesion, which may be to a certain extent localized. The surrounding effusion will otherwise serve as a medium for the wide diffusion of the more highly infective matter. This is especially liable to be the case in infections from the appendix or Fallopian tubes.

As a general rule the less existing adhesions are interfered with the better, *since their disturbance favours local absorption and wider diffusion* of the infection. Their separation can serve no useful purpose in preventing the formation of permanent adhesions, but rather favours the development of more resistant ones. None the less if it is found that adhesions include localized collections of pus, as may be the case when the condition is only attacked at a late stage, liberation of the confined pus is a matter of necessity if the operation is to be of permanent benefit.

Certain infections are less liable to be accompanied by the formation of adhesions than others; thus they are generally absent in the presence of streptococcus, usual in the presence of bacillus coli communis, common in gonococcal peritonitis, and variable when pneumococcus is the organism. In the last-named infection the condition may vary from a general bathing of the whole abdominal contents in pus without a single adhesion, to the presence of such sharply localized collections of pus in the lower abdomen that the sensation of a localized cyst may be experienced on examination.

Washing with saline solution, or other fluids, should be restricted to portions of intestine which may happen to be without the confines of the abdominal cavity; occasionally it is well to wash out a localized area of the cavity which has been serving as the seat of an operation, the remaining portion being protected with gauze plugs. Under all circumstances general flushing of the peritoneal cavity is to be avoided, as likely to enlarge the area of infection, and to favour the absorption of both bacteria and toxins. The importance of this rule, especially when portions of the cavity are affected from which diffusion is not as a rule free, such as the right hypochondriac region, the right iliac fossa, or the pelvis, is very great. Evisceration for the purpose of cleansing the intestines and the peritoneal cavity is still more strongly to be

deprecated, since to the objections already raised to the process of flushing must be added great increase of shock, increase of distension of the exposed coils, and a definite lowering of their vitality.

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The most effective drainage is obtained by the use of large-sized rubber tubes, but when it is desired to maintain a free opening for more than twenty-four hours, it is well to supplement the tube by the passage of a gauze plug by its side ; or, where two tubes are inserted in different directions from the same opening, by the introduction of a gauze plug between them so as to preserve a temporary potential space. The plugs are of use as acting by capillarity, and still more by maintaining a sufficiently free separation of the margins of the abdominal wound, which tend to rapidly contract around a simple tube. It is to be constantly borne in mind that the presence of a drain involves the formation of surrounding adhesions, hence the large gauze tampons formerly used freely are to be avoided. The employment of such large plugs, inserted for instance into

the pelvic cavity, may lead to the formation of adhesions between as much as a fourth of the whole extent of the small intestine with all its attendant risks and inconveniences.

Enterotomy and enterostomy. In some cases of peritoneal infection accompanying acute obstruction of the intestines, and in perforative infections of some standing, great distension of the bowel combined with paresis of the wall may be present. In such cases evacuation of the contents of the bowel may be desirable, either for convenience in manipulation in dealing with the site of the initial lesion or for the replacement of escaped bowel. For these a temporary enterotomy suffices. In others a marked degree of paresis of the intestinal wall, together with a highly toxic condition of the intestinal contents, may render it desirable to establish a temporary enterostomy. For this purpose a Paul's tube may be tied in, or, if it be considered that a mere vent will suffice, the method of Witzel may be employed (see p. 401).

After-treatment. The patient should be placed in the 'almost sitting position' of Fowler. To maintain this attitude, which resembles that obtained by the use of the double inclined plane, a pillow is placed beneath the knees and fastened by webbing attached to its two ends to the posts at the head of the bed, and support is afforded to the feet. The position eases the respiration, and favours gravitation of the peritoneal effusion into the less absorbent area afforded by the pelvic peritoneum. Passage downward of the fluid is also helped by the general peristaltic movements of the small intestine.

Vomiting. That due to the anæsthetic may be treated by copious draughts of warm water, to which is added a drachm of bicarbonate of sodium. By this method the after-effects of chloroform absorption are combated, and the stomach is washed out automatically. Irritability of the stomach may be quieted by the administration of cocaine in quarter to half-grain doses, or by the administration of a couple of drops of tincture of iodine in a wine-glassful of water. In more severe cases, especially if there be distension, gastric lavage may be resorted to with much benefit.

Feeding. Should vomiting persist, feeding by the mouth is useless; in any case, nothing but sips of warm water only are to be allowed during the first twelve hours. Later it is best to commence with albumen water, whey, or milk and soda-water. To these may be added some of the various patent foods, and meat extracts after the first twenty-four hours. Thirst in the early stages is best met by infusion of normal saline solution *per rectum.*

Rectal infusion. Infusions of normal saline may be given at intervals, or the continuous method of Murphy may be employed. If the inter-

rupted method be chosen, a pint of fluid may be given with a funnel and tube every four hours.

When practicable the continuous method is to be preferred. A convenient apparatus is shown in Fig. 245. Murphy objects to a regulating clip on the syphon tube; he says it prevents reflux to the cistern if expulsive efforts are made by the patient, and that escape takes place by the anus and the patient's bed is wetted. The delivery tube is fixed by strapping to the patient's thigh.

The fluid should be kept at a temperature of 100° F., and the flow so regulated as to allow the supply of about one and a half pints in two hours. The flask needs to be elevated only a few inches above the level of the patient's buttocks. By this method some eighteen pints may be introduced in the twenty-four hours, but watch must be kept on the patient's pulse to see that it does not become too full, and care must also be taken that pulmonary œdema is not produced.

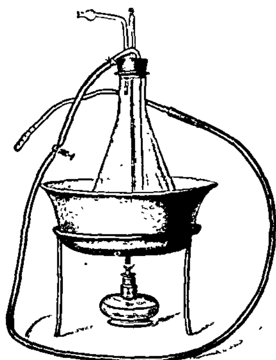


FIG. 245. FLASK PROVIDED WITH THERMOMETER, BLOW TUBE TO START THE SYPHON ACTION, AND DELIVERY TUBE TO RECTUM. It is placed in an iron basin containing water, beneath which a spirit lamp is arranged.

The infusion relieves thirst, combats shock, quiets the patient, and by favouring free renal excretion aids in the elimination of toxins and organisms from the general circulation.

Sleep. Insomnia is mainly due to toxæmia, and the use of saline infusion, and sometimes of sera or vaccines, may be of help. Morphia, as hindering free excretion and favouring the occurrence of intestinal distension, is to be avoided. The introduction of fifteen grains of aspirin into the rectal infusion is often useful, and if hypnotics are used, either veronal or sulphonal is perhaps the least objectionable.

Distension. Intestinal distension in late cases is often beyond the limits of treatment. When not due to complete atony, gastric lavage and the alternation of an occasional enema containing from half to one ounce of turpentine may help. Again, the passage of a rectal tube often allows the escape of flatus in considerable quantity. Hypodermic

injections of eserine salycilate, gr. $\frac{1}{100}$, often favour intestinal peristalsis, as do also small repeated doses of calomel, $\frac{1}{2}$ or 1 grain, which at the same time help intestinal asepsis. In bad cases large doses (up to one ounce) of sulphate of magnesia are useful.

Sera and vaccines. The acute nature of the disease restricts the early employment of sera to stock preparations. Polyvalent sera of bacillus coli communis, streptococcus pyogenes, or pneumococcus may be useful. The first injection should be made before the patient leaves the operation table. The routine inoculation of a culture tube in all cases renders it practicable to prepare a special vaccine which may be substituted for the serum later if desired.

Dressings should be frequent if discharge is free, and the surface of the abdomen should be carefully cleansed on each occasion. Drainage tubes must be retained as long as any discharge persists ; they should be shortened rather than diminished in calibre prior to removal, when they have been retained for more than a couple of days. A small gauze plug may be substituted when the tube is finally removed.

Results. Those obtained by the surgical treatment of diffuse peritoneal infection due to perforations have been already referred to under the special sections devoted to that subject (pp. 379, 385, 391, 394, 515). A general numerical computation from statistical records can hardly serve any practical purpose, since authors differ so widely in their views as to what is to be designated '' diffuse ' infection.

The prognosis in any given case depends upon the nature of the infection, upon its duration, upon the extent of peritoneal surface involved, and upon the locality infected. Thus streptococcic and bacillus pyocyanic infections prove almost uniformly fatal, the rare staphylococcic are somewhat less serious, while infections by bacillus coli communis and the gonococcus are comparatively favourable. Pneumococcus infections may be rapidly fatal, or in other cases tend to localize themselves securely and lead to moderate sized abscesses. A large proportion of all peritoneal infections are of a mixed character. The treatment of acute infections of more than thirty-six hours' duration is unpromising, and when more than one-third of the peritoneal cavity is involved the prognosis is very unfavourable. Infections of the central area of the abdomen occupied by the small intestine are especially dangerous on account of the rapidity with which diffusion is effected by the peristaltic movements of the bowel, while in such comparatively quiet situations as the right hypochondrium and the right iliac fossa diffusion takes place more slowly, and localization develops more readily. Systemic absorption is much more rapid and abundant from the upper abdomen than from the pelvis.

SECTION IV

OPERATIONS UPON THE STOMACH AND INTESTINES

PART III

OPERATIONS FOR HERNIA

BY

ARTHUR E. BARKER, F.R.C.S. (Eng.)

Professor of Surgery, University College, London; Surgeon to University College Hospital; Consulting Surgeon to the Queen Alexandra Military Hospital, Millbank

CHAPTER XV

THE RADICAL CURE OF HERNIÆ IN GENERAL

In this article 'Hernia' is taken to mean protrusion of portions of the contents of the abdominal cavity through any part of its walls.

The operative treatment of hernia will in the first place include those measures undertaken to prevent the *occurrence* or *recurrence* of the condition at certain points in the parietes known either to be congenitally unclosed or weakened by injury of any kind subcutaneous or open. In the next place it will include the procedures adopted to relieve patients of the *consequences* following on protrusion and constriction of the viscera through the openings in the parietes. This is as much as to say that the subject will be divided into the *preventive* and *remedial* operative treatment of hernia. The latter will deal more particularly with the dangerous accidents which frequently supervene when the viscera are retained in the hernial sac and undergo morbid changes.

The highest ideal that an operator can keep before him, in endeavouring to prevent the formation or recurrence of a hernia at a weak point, is to reproduce as nearly as possible the structural conditions existing in a normally developed healthy abdominal wall at such a point. But it is perfectly obvious that in many cases this cannot be achieved. There are many people who from their birth do not possess a normal average abdominal wall. Their muscles and aponeuroses are weak and their various congenital rings are more than usually insecure. There are besides many who from their occupations or habits fail to develop the muscular and tendinous tissues of the abdomen to an extent necessary to retain its contents at certain spots once injured under abnormal conditions of strain. In patients who from birth have thus had weak abdominal parietes, or who have a congenital tendency to obesity, it cannot be expected that any surgical operation for the cure of a hernia will have as good a prospect of permanent success as in those whose tissues are of the normal standard of strength. Indeed, it may be said with almost certainty that, apart from those following open or subcutaneous wounds of the abdominal

parietes, no man or woman ever develops a hernia by strain in a perfectly healthy condition of the walls. In other words, the accident cannot be held to be more than a determining cause.

Those herniæ produced in the scars of open or subcutaneous wounds are quite another thing. These may be produced in perfectly healthy well-developed individuals. Moreover, it must be remembered that the arrangement of the fibres of scar tissue after any operation is less perfect in its adaptation to resist the strains put upon it than are the original normally developed structures. This fact needs to be taken into account by all surgeons as a reason for limiting their incisions through muscles and aponeuroses as far as possible in all abdominal operations, and also as a ground for removing scar tissue until normal structures are reached in all procedures for closing ventral herniæ, the result of yielding cicatrices after earlier operations. It also supports the argument that in some cases in which the patient has a naturally thin-walled abdomen, often associated with obesity, the most perfectly healed union of the tissues will not ensure with certainty against a recurrence of the rupture, and that some measure for reinforcing the scar, *i.e.* by the implantation of wire networks periosteum or tendon, may have to be adopted. From all this we see that when the term 'radical cure' is employed it is, or should be, always with a certain amount of reserve; for, given abnormal tissues to work upon, we can hardly hope to produce a perfect *restitutio ad integrum* by any form of operation, however well designed.

Difficulties and dangers. Another preliminary question now forces itself upon our notice here. Is it possible or desirable to attempt the radical cure of *all* herniæ? Quite apart from the possible dangers of the general anæsthetic most commonly employed, and the risks of bronchitis, pneumonia, shock, &c., there are reasons why this question may be answered in the negative. Of course, where heart, lung, renal, liver disease, or diabetes is present, every case must be considered on its own merits. But besides all this, in many patients with *very* large herniæ which have been neglected, not only do they run these well-known risks, especially as they are generally past middle age and obese, but they are subject to others due to the actual bulk of the protrusion.

It must be remembered that when a very large hernia has existed for a long time, the conditions within the abdomen become entirely altered. The muscles and other structures of the walls become contracted in proportion to the reduction in the capacity of the abdominal cavity due to the escape of the viscera into the sac. To reduce a large mass into the abdomen under these conditions and close the opening, completely alters the state of things within the cavity. Not only is the reduction most

difficult, but for some time after this the abdominal cavity is not large enough for its contents, and the only way in which space can be gained is by forcing up the diaphragm and pressing the blood out of the abdominal viscera until the muscles of the wall again accommodate themselves to the new state of things. This they will do in time, but in the meanwhile during the first few days after operation the dangerous effect of the limitation of the movements of the diaphragm, coupled with engorgement of the lungs and heart, especially in stout people, can be easily understood on reflection. And cases are on record in which such procedures undertaken for unusually large herniæ have caused death within a few days by practically stifling the sufferers. They have in fact had no room in the abdomen for the proper play of the diaphragm, and both heart and lungs at the same time have had increased work thrown upon them by the blood forced out of the abdominal cavity, while at the same time the thoracic walls have often lost much of their resiliency owing to age.

In every case of large abdominal hernia, these considerations have to be duly weighed. And before undertaking any operation for the cure of voluminous ruptures, the patients should be put to bed for a week or more, thoroughly purged, and restricted in diet, while daily attempts are made to reduce the mass partly or wholly. In some cases reduction may be nearly effected, and in others so little may remain outside the cavity that it is evident that the rest, if replaced by operation, would cause no embarrassment. By these means I have been able to deal successfully with many very voluminous herniæ, but in others, on failing, have been obliged to refuse operation.

Together with the above objections to operations on very large herniæ, there is of course the mechanical difficulty of bringing together the edges of the wide openings securely. But though this is great and sometimes almost insuperable, much can now be done by reinforcing the line of suture by the transplantation of tendinous expansions or the insertion over it of silver wire networks. Moreover, where the intestinal contents of a large hernial sac are very much adherent and matted together or otherwise seriously damaged, it is decidedly better to resect a portion or the whole of the tangled mass, if the conditions are otherwise favourable and the length of gut be not too great, than to return it into the abdomen with the chances of adhesions and obstruction following, or even of perforation. This, although a bold measure and not for any one to undertake lightly, is, I believe, a safer procedure and has given me the best results during the last few years (see Fig. 246).

But by far the greatest risks in such cases in these days of improved technique and asepsis are those of *the general anæsthetic* employed, and

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the consecutive lung, liver, and kidney troubles, especially among patients past the meridian of life. Much has been done to reduce these risks by careful administration, but they still remain considerable, and almost the only ones when simple radical cures are in the hands of expert surgeons.

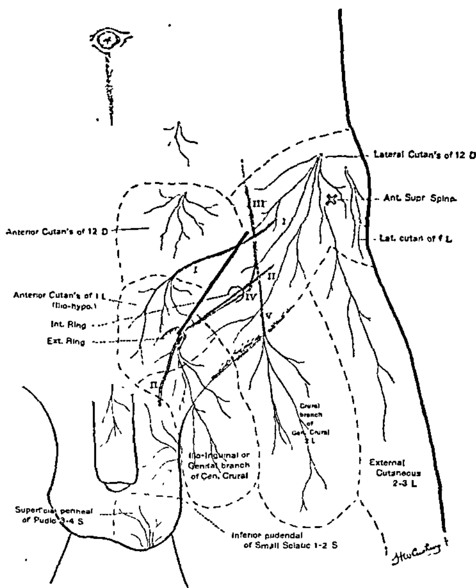


FIG. 247. COURSE AND DISTRIBUTION OF THE NERVE-SUPPLY OF THE INGUINAL AND FEMORAL AREAS. (*Cushing.*)

The cleansing of the mouth and teeth in all cases, and the washing out of the stomach whenever suspicions of foulness exist, have done much to favour uninterrupted recovery without lung complications. And the more frequent resort to local and spinal analgesia will, I think, do much more when better understood and more largely practised. Already much has been done in this direction, and in my own work now it

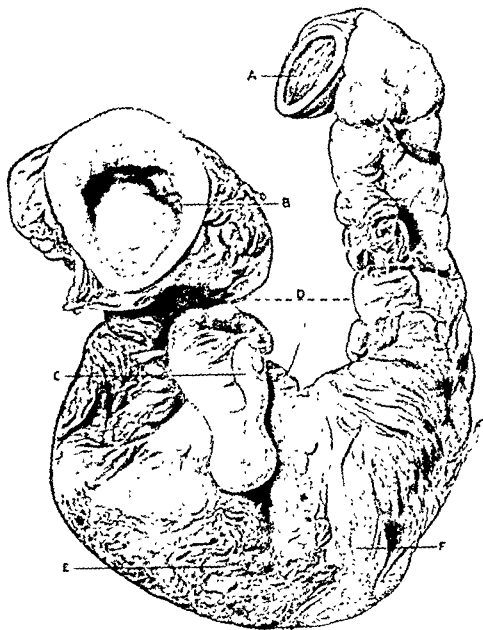


FIG. 246. ENTERECTOMY FOR STRANGULATED HERNIA. Parts removed from a semi-strangulated and almost universally adherent right femoral hernia in a woman. A, Divided end of the lower part of the ileum; B, Divided ascending portion of the cæcum; C, Vermiform appendix; D, Line of constriction at the femoral ring; E, Roughened damaged portion firmly adherent to the sac; F, Smooth non-adherent portion. The strangulated loop consisted of the lowest part of the ileum and the vermiform appendix with part of the cæcum, and after dissecting through the adhesions was considered too unsound to be replaced within the abdomen. I therefore resected it *en masse* through the ascending colon and ileum, the latter being implanted end-to-side in the ascending colon. The patient, æt. 53, made an excellent recovery in spite of intercurrent bronchitis. About half actual size. (*From the Museum of University College Hospital Medical School*, No. 1599 a.)

From all this it is plain that in every operation for hernia means must be taken to guard against chill of the abdominal wall and viscera, and to minimize all rough manipulations as far as possible and especially of the parietal peritoneum. Every moment of time which can be saved in operating is of the utmost importance in these cases where the abdomen is exposed and opened; and it is quite possible with practice to cultivate rapidity of manipulation without roughness or loss of accuracy. The shorter the operation, moreover, the shorter is the depressing toxic effect of the drugs employed for general anæsthesia, and the smaller the chance of septic infection of the wound from the air, &c.

Preparation of the patient. Besides these considerations, the general preparation of patients about to undergo an operation for hernia includes not only measures to secure complete asepsis of the skin, but also of the intestinal tract as far as attainable. For we must never overlook the possibility in complicated cases of being obliged, for one reason or another, to resect intestine. The bowels are therefore carefully cleared out beforehand by laxatives and enemata for several days if possible; the diet before and after operation must be simple and consist of cooked food. In addition to these, carbonate of bismuth or B. naphthol is given, of which I give the preference to the first, under the belief, which appears justified, that it is a valuable intestinal antiseptic. The necessity of guarding against chill during operation has already been noticed. Personally, I regard the wrapping of the whole body in warm wool beforehand as the best practical means of achieving our aim whether the operating table is warmed or not. This wrapping is not removed until complete recovery from the effects of the operation is beyond doubt.

Sutures. As to the material to be used for sutures of the abdominal wall, gut, omentum, or mesentery, we have a large choice and each surgeon has his favourite. For my own part, having used all those commonly known, and acknowledging good qualities in each, I have for years past given a decided preference to the ordinary fine *linen* thread made from the best flax fibre for Singer's sewing machine. The numbers which will be found most suitable are 90 (finest: black), 60 (medium: red), and 40 (strong: white). This thread is prepared by simply boiling it in water for an hour and storing it in rectified spirit. The colours are aniline dyes and enable the surgeon at a glance to recognize the size. Some of the dye comes out in the boiling and some more in the spirit, but enough is left to recognize the different threads even at night, and this trace of dye is quite innocuous to the tissues. Like silk, this thread is not absorbed, but it is so very strong that the finest number leaves but an infinitesimal amount of vegetable fibre in the tissues, and being easily

is rare for a hernia to be operated on under *general* anæsthesia, its place being taken almost invariably by local or spinal analgesia (see Vol. I, p. 31).

To utilize local analgesia for operations on either inguinal or femoral hernia, a study of the nerves to be infiltrated is necessary to complete loss of sensation. These are well shown in Fig. 247. The areas supplied by these nerves of the groin overlap one another so completely at points that the injected fluid must be abundant enough to reach them all, and it will be necessary for the operator to bear in mind the track, superficial or deep, of each. The ilio-hypogastric, ilio-inguinal, and genito-crural will require special attention, and will need the use of the long blunt needle (see Vol. I, Fig. 4, p. 35) to introduce the injection fluid into deeper parts. The other nerves can be reached by the shorter needle.

That the parietal peritoneum is largely supplied with sensory nerves is no longer open to any doubt. The special clinical observations of Lennander, the anatomical researches of Ramström, and the histological studies of Dogiel and Timofejew have quite recently cleared up this obscure field. And every one who is familiar with their writings, or who has even carefully studied their exquisite figures of what they have discovered, cannot fail to realize the extreme sensibility of the parietal peritoneum which is borne out by all our clinical experience. As to the visceral layer of this structure, it is also clear that, so far as the root of the mesentery is concerned, it also receives sentient nerves, while that covering the intestines is insensitive. The exposure or handling of the parietal peritoneum, or dragging on the mesentery during a long operation, cannot therefore fail to produce a profoundly depressing effect upon the patient's nervous system even under a general anæsthetic.

Whether spinal analgesia abolishes *all* nervous impressions as well as pain below certain roots and thus prevents the ill effect of these impressions may be open to question, but there appears to be strong ground for the hypothesis. And from what I personally have seen in hundreds of my own cases, I am satisfied that complete spinal analgesia, reaching high enough to abolish sensation throughout the abdomen, as a rule diminishes shock enormously, though it does not seem to prevent it in every case. The prolonged use of general anæsthetics is also depressing to the nervous mechanism of the circulatory system.

Shock is also one of the risks we have to face in all these operations for large herniæ. This is not due to any loss of blood, for the hæmorrhage is only trifling in these procedures. It is due in part to the exposure of the abdomen and handling of its contents and of the highly innervated parietal peritoneum.

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sterilized it is in my opinion equal, if not superior, to any other material. It has another merit which recommends it to many of my surgical friends all the world over, *i.e.* that it can be obtained almost anywhere where a dépôt for Singer's sewing machines exists, and the cost is quite trifling. In the tropics, too, where silk is said to be very perishable, it takes its place. And although I possess quantities of the finest silks, they have been lying unused for years.

It would be too much to say that no one of these flaxen sutures ever makes its appearance on the surface or cuts in the skin. The same thing will be seen with sutures of silk or even of catgut. I will only say that such an occurrence is, in my experience, as rare with linen thread as with any other fabric. Even a sterile thread of any substance may cut out if it strangle the included tissues so much as to cause them to necrose, and any thread may be infected on its way into a wound from the skin, a hair, or a sebaceous follicle. The error of tying sutures too tightly is, I am afraid, one which we all commit at times, and especially in radical cures of herniæ, where it is necessary to draw together strong and often somewhat rigid fibrous structures whose vascular supply is small. The young operator should be warned against it. Here it is only a question of drawing the structures of the various rings *lightly* together without crushing them. The processes of healing will not then be interfered with and the tiny thread will become encapsuled like any other small sterile foreign body.

Another advantage of this material is that it is so easily sterilized by the surgeon himself and he is independent of special trade products. Every surgeon who gives the small amount of trouble necessary to the sterilization of his own sutures and ligatures will find it worth his while, as Lord Lister did. He will save himself and his patients much time in the end by doing so, for there will be fewer flaws in the healing processes in his wounds and consequently in the patients' convalescence. Wire sutures and networks are alluded to in Chaps. XVI and XVII.

The question what materials are best for the dressing of wounds made for radical cures of hernia is now pretty generally settled in favour of sterile gauze. The wounds, being aseptic, do not require drainage except in some cases of large ventral and of inguinal herniæ where there has been extensive dissection of the sac in the scrotum. Here the tendency to oozing into the loose areolar planes of the scrotum will often require a gauze or other drain for forty-eight hours.

CHAPTER XVI

OPERATIONS FOR THE RADICAL CURE OF NON-STRANGULATED EPIGASTRIC, UMBILICAL, VENTRAL, AND DIAPHRAGMATIC HERNIA

EPIGASTRIC HERNIA

UNDER this name are known those small protusions anywhere in the linea alba between the ensiform cartilage and the umbilicus, which are occasionally seen and sometimes overlooked. They occur through small spaces between the interlacing fibres of the aponeuroses of both sides forming the linea alba, and often in patients otherwise well developed. As a rule they are not of large size before they begin to give rise to trouble. The pain, dragging, or cough appear to be produced by the stretching of the very sensitive parietal peritoneum as it forms a small tight sac. Such a sac rarely, if ever, contains either gut or omentum in my experience, but occasionally a small lobe of the latter is found in it. This supports the view that the symptoms are due simply to stretching of the peritoneum. In some of the cases on which I have operated a condition has been found which at first sight has been a little puzzling. When the lump was exposed it appeared to be composed entirely of fat covered by adherent peritoneum, and the conclusion likely to be drawn was that the fat was omentum. This fat, moreover, could often be drawn to a considerable extent out through the little ring in the linea alba, at first strengthening this belief. But in such cases, when the fat was carefully divided it was found that the peritoneal sac lay within it, and on opening this the true peritoneal cavity was seen, with or without a lobule of omentum in sight ; but gut was almost never seen. In fact, the first lobule met with was nothing more than subperitoneal fat pushed out before the sac and covered by fascia transversalis.

Operation. The operation which I have found perfectly satisfactory in these cases is very simple. It consists in making a vertical incision over the centre of the little tumour, clearing the fat from the fibrous ring in the linea alba after pulling it out as far as possible. The peritoneal sac underlying or in the middle of the lobule is then opened to see that there is no omentum within. It is then transfixed, tied

en masse, and cut away. A few silk or linen-thread stitches are then inserted in the borders of the ring, taking a good grip of them, and are tied without too much strain. The skin is then sutured without any drainage. This very simple procedure has never, so far as my own experience goes, been followed by recurrence.

UMBILICAL HERNIA

This hernia, although also in the middle line and but little removed from the epigastric, has, as is well known, a totally different origin. The cicatricial tissue which forms after the necrosis of the infantile umbilical cord is in many individuals very thin, and practically unites the peritoneum with the skin. In those patients, then, whose abdominal aponeuroses are badly developed this scar tissue is insufficiently supported, and yields to the pressure from within until a sac is formed, into which omentum at once enters as a rule. Subsequently, and not uncommonly, in large umbilical herniæ the colon may be forced into the sac, and later, but more rarely still, small intestine. In some of such cases the tissues covering a part or the whole of the protrusion are so thin that it seems strange that they can ever bear the bursting strain put upon them from within continuously, and at times spasmodically, as during cough. Once formed, such a protrusion has a great tendency to increase rapidly. Several forces are now at work. There is first the pressure from within as before, which is also wedging the protrusion between the recti muscles and tending to separate them more and more and enlarge the opening; there is besides the effect of gravity upon the contents of the hernia, which are now unsupported by anything but thin non-muscular coverings, and drag downwards in ever-increasing ratio as their weight becomes greater.

These points have a strong bearing upon the question of attempting the prevention of such hernia by operation. This question hardly arises during infancy and childhood, when such umbilical herniæ are very common, as it is well known that they have a natural tendency to heal if well supported by some simple bandage. But in middle life, when degenerative changes in the tissues are common, and fat accumulates in the tissues as well as in the omentum, we have to face the question whether the patient should accept the risk of operation for the closure of the umbilical opening before great protrusion has taken place, or accept the well-known dangers of the latter, with the prospect of ever-increasing volume of the contents, and greater difficulty in closing the opening securely, and often under conditions of incarceration with adhesions or even of strangulation. The older the patient, the less chance he has of recovery from the latter. My own practice has been to advise

all fairly healthy adults suffering from umbilical hernia to submit to operation, unless there is some distinct contra-indication such as age, chest trouble, albuminuria, or diabetes, or, for reasons given above (see p. 564), an inordinate protrusion of viscera. As to controlling such herniæ by bandages, trusses, &c., in stout people, I think most surgeons of large experience will agree that the prospect is not good, and that they increase in volume in spite of any appliance.

Operation. Having decided to operate for the radical cure of a *non-strangulated* umbilical hernia, the patient should be put to bed for at least a week beforehand. During this time the food should be restricted in amount and mostly fluid. At the same time means must be adopted to effectually unload the bowels. By both these measures a certain diminution in the general volume of the abdominal contents can be brought about, favourable to the reduction in whole or in part of the protrusion, and to the decrease of strain on the stitches when the opening, be it large or small, is closed. If the hernia be voluminous and does not subside spontaneously in the recumbent position, it should be carefully but firmly reduced frequently during the week, if possible wholly, or as far as feasible. If it contain adherent omentum, this should be manipulated by pretty firm squeezing into the abdomen, and left there under a retaining bandage. All this will tend to accustom the abdomen to the replaced contents, and will improve the condition of the skin overlying the sac, which is often in an eczematous and foul condition. Otherwise the cleansing of the skin for operation will follow the usual rules and should be carried out daily. No operation, unless in an emergency, should be undertaken unless it is quite sound and clean. But it is not always an easy matter to render the skin aseptic. It is sometimes raw or ulcerated. In a private case recently under my care, where ulcers had been present some weeks before I saw the lady, they had perforated into the sac a few days previously to my operation. It was treated by boric fomentations, and the ulcerated skin was then kept from contact with other parts by being held up in tenaculum forceps while the operation was proceeded with, and was enveloped in gauze as progress was made, and until the loose skin and sac were completely removed. The result was primary union without a flaw.

The first incision should always be made over the lateral aspect of the hernia. Commencing in the middle line an inch or two above the neck of the tumour, it should curve over the side of the latter and end in the middle line an inch or two below the neck. On the opposite side a similar incision is made, so that two shallow flaps are formed designed to meet in the middle line. These incisions should not open the sac at first, but just enable the flaps to be drawn off the neck to its base,

the intervening part being held up. Here, when the sac is opened just external to the ring *above*, there will always be far less chance of meeting adhesions between gut or omentum and the sac than at its most prominent or lower part, where it is not safe to open it on this account. When the sac has thus been entered with caution close to the upper part of the ring, and it is seen that there are no adhesions of intestine with the latter, any omentum found should be at once tied off at the level of the opening in the abdominal wall and cut beyond the ligatures, the stump being reduced into the peritoneal cavity after careful examination to see that there are no bleeding points in it. If there be no gut in the sac, or if it has been reduced, nothing remains but to excise the skin included between the two lateral incisions, and with it the corresponding sac and all the omentum adherent to it which was previously severed from the abdominal portion. This saves time and loss of blood, as there is no need to separate the sac from the protruded omentum; both are simply taken away with the skin covering the hernia in one mass. If bowel should be found adherent at any spot it will need to be dissected away from the sac with the greatest care, lest it be opened or weakened. In some cases the portion of the sac adherent firmly to it, if small, can be left attached to it and severed from the rest, rather than risk damage to the gut from extensive or deep dissection. But in a few cases with very extensive adhesions it may be better, as already hinted (see p. 565), to resect the adherent gut in healthy tissue and join end to end, than to damage it severely by dissection of the adhesions and then return it covered by raw patches, denuded of peritoneum, and ready to give way, or if not quite so far damaged, at least prone, if not almost certain, to contract fresh adhesions within the abdomen. In one or two of my own cases this resection was done, and in each with success (see Fig. 246).

The method of closing the actual ring of an umbilical hernia should be varied according to the size of the opening. When it is comparatively small, and the structures around are well developed, simple suture with thread, in a way to be presently described, will, if properly done, be quite adequate. But where the ring is unusually large, the recti weak, and the aponeurotic structures thin, there can be but little doubt that one or other form of buried silver network to reinforce the suture will be desirable if we are aiming at a permanent result.

(*a*) In the case of a moderate-sized ring, say with a diameter of 1½ inches and with fairly thick abdominal walls, a very simple method which I formulated for myself many years ago has yielded the very best results as regards safety and permanence of results. In the first place, the sac is drawn forward, transfixed at two or more points, and tied firmly at the level of the opening. The sac is then cut away and the stump

allowed to retract into the abdomen. In my own cases the sutures for all this work have for many years been Singer's sewing machine *linen* thread, No. 90 (from Barber's manufactory) or No. 60, as already noticed above (see p. 569).

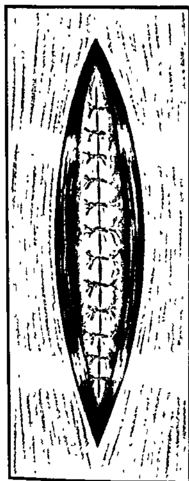


FIG. 248. UMBILICAL HERNIA. *Closure of the ring.* Edges of the ring of an umbilical or ventral hernia closed by sutures which include fascia transversalis and the posterior layer of the sheath of the rectus muscle. The anterior layer of the rectus sheath is free, and beneath it the muscles are seen on either side.

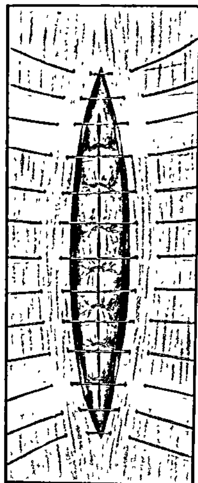


FIG. 249. UMBILICAL HERNIA. *Closure of the rectus sheath.* Mode of entering the sutures on either side through the anterior layer of the rectus sheath, so that when drawn together the edges shall be folded inwards and a broad surface of contact be made between them.

The edges of the fibrous ring, *not* cleanly dissected but left as much undisturbed as possible, are now brought together by the same No. 60 linen-thread stitches placed about ½ inch apart and taking up a good roll of tissue (see Fig. 248). A second row of stitches is now passed through the anterior part of the rectus sheath, in the manner indicated in Fig. 249, so

that when drawn together and knotted the first row is folded in (see Fig. 250) and the parts of the sheath included in them approximated over a considerable area without strangulation of the tissue. Upon this the flaps of the skin are united in the usual manner. In such cases a small strand of gauze is usually desirable as a drain in the lower angle of the wound, on account of the largeness of the potential cavity under the flaps, which are usually stretched across a space between a considerable depth of fat on both sides. In this space, unless drained, there is much tendency to the collection of serum and oily matter from the superabundant fat, which will delay union even if it do not favour suppuration. This drain can be removed in forty-eight hours or perhaps a day later, after which there is little secretion to be feared.

(*b*) The second method is only required for those patients whose abdominal walls are very thin and whose ring is very large, so that there is

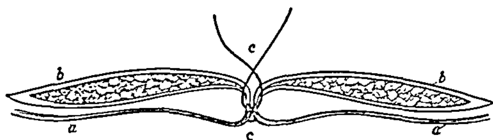


FIG. 250. A SIMPLE MODE OF CLOSING AN UMBILICAL HERNIA. Cross-section of the abdominal wall. *a*, *a*, Peritoneum and edges of the ring first drawn together at *c*, *c*; *b*, *b*, Recti muscles, the edges of which are folded inwards by the suture *c*, *c*.

but little prospect of forming a sound barrier against the redescent of the hernia by suture alone as above. Here the whole procedure, as far as the closing of the sac and the edges of the ring, is the same as that just described. But when all this is completed the rectus sheath is opened on both sides about ½ inch from the first line of suture, by vertical incisions curving to meet above and below. These ought to expose the muscle substance on both sides (see Fig. 248). From this the anterior layer of the sheath is separated with a blunt curved director all round the opening, aided by an occasional snip with scissors opposite the lineæ transversæ. A wire filigree (see Fig. 251) is then laid down upon the first line of suture, which it should overlap by an inch in all directions. Its loops are then tucked in under the edges of the divided rectus sheath and carefully flattened out on the muscles on both sides (see Fig. 252). The divided borders of the anterior layer of the sheath are then drawn inwards over the filagree and are united in the middle line with thread sutures (see Fig. 252).

This method of strengthening the weak spot of the abdomen is highly to be recommended in particular cases, yielding as it does remarkably good

permanent results. For some years before perforated silver plates were introduced by Witzel in Germany, and the filagree by Bartlett in America, I was in the habit of doing all the stitching in these severe cases with silver wire, the ends of which were spread out and interlaced to form a network in the tissues. The results were admirable. But a great deal of time

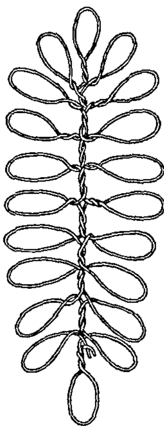


FIG. 251. SILVER-WIRE NETWORK. For insertion between the layers of muscle in ill-developed abdominal walls where radical cures are attempted. The network is made out of one continuous piece of wire. In the figure the wire is drawn much too thick; it should be about the thickness seen in Fig. 269, p. 599.

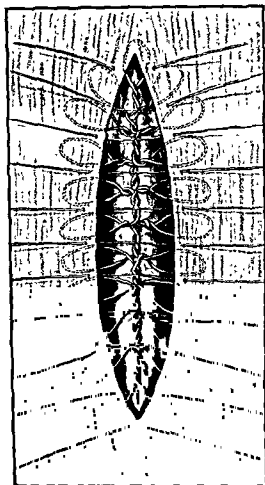


FIG. 252. SILVER-WIRE NETWORK IN VENTRAL HERNIA. Silver-wire network inserted under the anterior layer of the rectus sheath and the sutures in the latter ready to be tied over it.

was spent in such an operation in forming the interlacement *in situ*, and many wires had to be used, whose ends sometimes caused a certain slight amount of uneasiness later. But by the preparation of the networks beforehand (see Fig. 251), fashioned, as I have been in the habit of making them, out of one continuous piece of wire, having, therefore, only

two free ends at the lower pole, much time is saved and a much more uniform support achieved. I have had nothing but the most satisfactory results from the use of these filagrees in the many cases in which they have been employed.

They can be easily made of the required size and shape in a few minutes by the surgeon himself and are easily sterilized by boiling. Before this they should be heated nearly red hot to soften the silver, which may have been rendered brittle by the necessary twisting. This should be done with care on a hot plate of thin metal. As the wire is fine (about No. 30 Imperial Wire Gauge) it is often melted if passed naked through a spirit-lamp flame and the network is spoiled. No better illustration could be given of this method than a private case in which I operated in a neighbouring county while engaged on this article.

A lady of sixty-five, excessively obese, weighing about 18 stones, and very subject to bronchitis, had a large umbilical hernia for years with a ring about 2×2 inches. The mass consisted of omentum and a loop of small intestine which was reducible. She had had an attack of left hemiplegia five months before, only partially recovered from. I was sent for because a slough on the left side of the mass had given way and the sac water was running out abundantly. As the whole tumour was very foul and the integument around acutely eczematous, it was necessary to devote thirty-six hours to fomentations and other antiseptic measures. On account of the bronchitis and also dread on her part of a general anæsthetic, I used local analgesia by the method I have employed for the last ten years (see Vol. I, p. 31). Spinal analgesia appeared undesirable on account of the nervous lesion resulting in hemiplegia. The operation was done as just described and the result earned her enthusiastic gratitude. The main difficulty here was to keep the fresh wound from being infected by the foul sac and skin. These were held up in tenaculum forceps while the incisions were made, the omentum tied, and the stump reduced when they were cut away, the remaining tissues being clean. The operation lasted about an hour and a half, during which the patient was in a most satisfactory condition. Union was perfectly flawless, and the absence of respiratory trouble and shock or vomiting no doubt contributed to the very encouraging result. Now, more than a year later, she is perfectly well without any trouble from the network.

It is well here to emphasize again the fact that in all radical cures of herniæ we are inclined to tie our sutures with too much force. What is required is merely a light approximation of the structures included in the ligatures. If anything further be done the tissues are more or less strangulated, and in some cases the stitches may cut their way to the surface though quite aseptic. In any case the semi- or complete strangulation produced by too tight suturing lowers the vitality of the tissues included, and consequently decreases their resistance to infection, besides

leaving weak spots at each stitch-hole. As illustrating this last point I have seen more than one recurrence of hernia opposite a stitch-hole even where flawless primary union had taken place, and believe too tight suturing to have been the cause. The cleaning of fibrous rings by too minute dissection is also to be deprecated. If this be done the vascular supply of the tendinous strands is often cut off by removal of the areolar tissue in which the small vessels run. Only sufficient dissection to enable the parts to be clearly distinguished from one another should be indulged in; in fact, as little as possible with this end in view.

VENTRAL HERNIA

The many varieties of this hernia, so common nowadays in consequence of the large number of abdominal sections performed for one disease or another, suppurative and non-suppurative, do not all require detailed and separate description. The general scheme given for operations on umbilical herniæ will cover these too (see pp. 573 *et seq.*).

The same may be said of those herniæ in various parts of the abdominal wall due to subcutaneous ruptures of muscles from strain.

Operation. Both these varieties may be cured by suture of the openings as described, with or without the insertion of wire networks. The latter will be specially useful where, after rupture of a muscle, the torn ends have retracted from one another. Here it is quite impossible to bring the soft friable muscle-tissue of the two ends into contact by sutures, and the gap may be supported by a wire filagree over which the sheath or aponeurosis may be sutured as above.

DIAPHRAGMATIC HERNIA

This is a very rare form of displacement of the contents of the abdomen through its boundaries, apart from congenital defects and punctured wounds of the parietes penetrating the diaphragm as well. Specimens of the first form are to be found in dissections of newly born infants in all museums, and one of the latter, where recovery followed without operation, may be seen in University College Hospital Museum. Personally, I have only seen one case of diaphragmatic hernia in an adult. It was in the hands of a provincial surgeon who operated for obstruction without discovering the seat. After death the hernia was discovered.

Operation. No definite rules can be laid down for operation in such cases. The diagnosis must always be extremely difficult, and will in all probability only be made, if made at all, on opening the abdomen. But if discovered the rent in the diaphragm might be closed by stitches.

CHAPTER XVII

OPERATIONS FOR THE RADICAL CURE OF NON-STRANGULATED INGUINAL HERNIA

FACTORS INFLUENCING THE CHOICE OF OPERATION

SEVERAL varieties of inguinal hernia are generally recognized, and the operations performed upon them will vary according to their anatomical varieties, their contents, and, finally, according to the pathological changes in the protruded viscera.

Whether an inguinal hernia is reducible, incarcerated, or strangulated, is the most important consideration in connexion with operation on it. Next to this is the question whether it is from the first congenital or acquired. In the ordinary course of development the funicular process of peritoneum produced by the descent of the testicle and cord closes and becomes obliterated. But in some individuals it remains more or less in the embryonic state. In such a case the muscular internal inguinal ring and the tendinous external are usually imperfectly developed, and consequently give inadequate support. It seems almost certain that no inguinal hernia is produced by strain without some such weakness predisposing to it. In other words, a normally developed individual does not acquire an inguinal hernia even under strain.

But besides these herniæ there are others which take a different direction in the inguinal region. In the first place, the protrusion of the peritoneum may lie inside of the epigastric artery instead of external, while still escaping through the internal ring—the 'direct hernia' of some writers. Others reserve this term for the variety which bursts through the conjoined tendon and thus reaches the cord as it escapes through the external ring. This is a rare form, and the writer can only remember one well-marked example of the kind in the many hundreds of herniæ on which he has operated. In this a sharply defined opening was found directly in the middle of the conjoined tendon, and through this the hernia had left the abdomen. It had not passed through the usual internal ring. Such a condition would call for a modification of the usual operations, as would also the following.

A sac, having been pushed before the bowel through the internal ring, may turn upwards and outwards between the internal and external

oblique muscles, or between the internal and transversalis. Such 'interstitial' forms may be also combined with another ordinary sac which follows the cord as usual. A good instance of this bifid form is represented in Fig. 253, drawn from a case operated on by the writer some years ago (*Brit. Med. Jour.*, Sept. 10, 1898). Here the neck of the bifid sac is seen at the internal inguinal ring and one arm passing with the cord into the scrotum, while the other runs upwards and outwards above Poupart's ligament under the external oblique muscle. Between the two arms ran the deep epigastric artery and vein in the usual direction

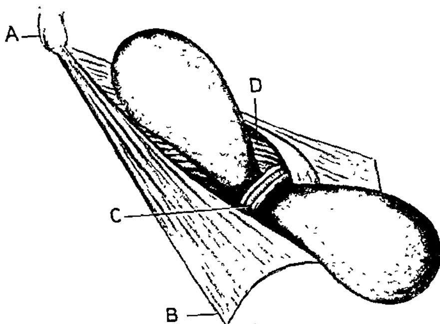


FIG. 253. BIFID INTERSTITIAL INGUINAL HERNIA. A, Anterior spine of the ilium; B, Aponeurosis of the external oblique muscle slit open and turned down, showing the double hernial sac, the outer pouch lying on the internal oblique muscle, the inner running into the scrotum; C, The deep epigastric artery and veins separating the two pouches of the sac; D, *The internal oblique muscle.*

upwards and inwards. Of course the sac was tied off at its neck before it forked, the condition having been fully recognized. A radical operation followed by one of the procedures described below.

We must also contemplate in some cases of obscure inguinal tumour the possibility of another variety of 'interstitial' hernia in which, instead of the peritoneum passing through the internal ring, it is forced between the fascia transversalis and muscle, and spreads outwards, upwards, or inwards, above the bladder. In such a case the neck of the sac would be embraced by fibres of the fascia transversalis and not by muscle, the whole hernial mass lying inside the muscles of the abdomen but outside the peritoneal cavity, a state of

things resembling *réduction en masse* of hernia. But, of course, there is in this case no question of *réduction en masse*, for the peritoneum may not have entered the inguinal canal at all, or only partly have done so. But there are cases in which a hernia has partially escaped through the inguinal canal, the greater part of its contents being interstitial between the fascia transversalis and muscle, and having no relation to the internal ring. Such a condition was recently met with by the writer and gave rise to considerable embarrassment during the operation. On opening the sac the bulk of the bowel could be pushed back through the rings, but obviously not into the general abdominal cavity. When the finger was made to follow it a large interstitial sac was found with a narrow neck opening into the general peritoneal cavity, and having no relation to the inguinal ring, and was plainly formed by the peritoneum strengthened by the fascia transversalis.

All these varieties must be borne in mind by every operator, and will modify his procedure in many cases.

Again, the important differences in the contents of inguinal herniæ must be remembered, as they also will modify the procedure. As a rule they will consist of small bowel or omentum, or both. But it must not be forgotten that in some cases the bladder is drawn into the rings with the peritoneum of the sac. This is not a serious complication if recognized and understood, but has proved very embarrassing in some recorded cases and has led to fatal mistakes in others. When recognized the bladder is simply pushed back before the rings are sutured. The danger is that it may be transfixed with the sac.

The cæcum and sigmoid flexure have also been met with in inguinal hernia, and I have found them very difficult to deal with. This was owing to their not having in all parts a complete covering of peritoneum. In such cases the herniæ appeared to have been produced by the slipping down of the partially-covered bowel behind the peritoneum into the sac. The consequence of this is that the outer part of the protruded gut is uncovered by peritoneum, and it is not possible to reduce it without at the same time returning the sac in whole or in part into the abdomen. To do this the surface of the cæcum or sigmoid uncovered by peritoneum has to be *very* carefully separated from the structures with which it lies in contact with due regard to its vascular supply. This is no easy matter with either viscus in some cases, and the dangers of cellulitis are enhanced by any rough handling. Only part of the sac can in most cases be removed, the rest is stitched up and reduced before the rings are closed.

METHODS OF OPERATING

Not so long ago almost all the operations for hernia were undertaken for the very dangerous complications, including incarceration or strangulation which usually followed when the rupture could not be reduced. Nowadays by far the largest number of operations are done for the prevention of the descent of the hernia, and there are relatively fewer cases of bad strangulation.

A very large number of procedures have been devised within the last few decades for the radical cure of inguinal herniæ, a review of which would be impossible here and unnecessary. The most recent and best have had one and the same principle underlying them all. Their aim has been to bring about by operation the nearest possible return to the anatomical conditions existing in the normal adult. The first element in this effort is in all to produce a flat plane of peritoneum over the point of exit of the hernia from the abdomen instead of the little pit, funnel, or canal which probably precedes all herniæ. The next is to bring the internal inguinal ring into its old position and normal size by drawing down the conjoined tendon to the *posterior* border of Poupart's ligament by sutures carefully inserted from within outwards *behind* the spermatic cord, leaving the latter only just enough room in the reduced internal ring to escape strangulation. The third point is to reduce the size of the external ring by stitching its borders over the cord from without inwards until it only barely allows the latter to pass into the scrotum. Opinions vary as to which of these three elements in the operations of radical cure is of most importance, but all are agreed at the present time that the closure of the external ring is least important. Some operators also lay stress upon the necessity of reducing the bulk of the cord by excising the greater part of its veins before closing the rings.

Personally, I regard the two first of almost equal value. It seems beyond question that to leave any pit or even slackness of peritoneum opposite the point at which the cord escapes from the abdomen is a mistake and invites recurrence. But not to reduce the size of the internal ring as far as possible is to leave a weak spot, into which the peritoneum, no matter how tense it may have been made, will in time tend to protrude. In the earlier operations perhaps too much stress was laid relatively upon the treatment of the stump of the sac, and of late there seems a tendency to lay *all* the stress upon the closure of the internal ring and its displacement outwards. To be properly carried out, both factors in the operation must be most scrupulously attended to.

In the earlier open operations designed to include both requirements,

attempts were made to close the sac high up and to reduce the size of the internal ring *without dividing the aponeurosis of the external oblique* by enlarging the external ring from within outwards. Two methods which were introduced about the same time and independently may be mentioned here; my own and Sir W. Macewen's. Both these gave excellent results in moderate-sized herniæ, and for children I still employ my own method, which is one of the simplest, believing that to avoid division of the external oblique aponeurosis is most desirable. For larger herniæ, however, in adults, I think we have a better method in Bassini's, which exposes the internal ring and conjoined tendon by slitting up the aponeurosis of the external oblique, and which enables us to stitch the conjoined tendon to the posterior border of Poupart's ligament accurately behind the cord and bring the internal ring into its original position.

Before proceeding to discuss in detail the various methods for preventing the descent of inguinal herniæ, some points common to them all may be mentioned here in order to save repetition. The incision for each may be said to be the same, sometimes a little longer or shorter perhaps, but always running obliquely downwards and inwards directly over the rings. It is well to limit as far as possible its extension over the pubis and scrotum. The abundance of hair and sebaceous follicles in this region renders it particularly difficult to cleanse the deeper layers of the skin from all bacteria by any known method of washing. And though the surface of the cutis may be freed from all organisms by repeated cleansing, any stitches passing through the deeper parts may be infected from the follicles and spoil an otherwise ideal result. In some cases where there is not much subcutaneous fat, I have been in the habit for years past of dispensing with all stitches in the skin and of closing the wound by collodion and gauze. This is best done by placing a fine hook at the upper and lower angle of the incision and drawing its ends apart. This brings the edges of the wound together evenly and with the same tension if the hooks are at the same time pressed towards the deeper parts. Gauze is then evenly laid over the incision and painted with celloidin collodion nearly up to one edge on one side. When this is dry the gauze is drawn taut from the other side, when the collodion is painted over it nearly up to the wound, but not covering it. When this side is dry, the dressing is applied and pressed on the wound while the hooks are removed Then the usual padding and bandages are fixed on firmly.

In preparing the skin beforehand, it should be remembered that several washings extended over some days before operation are better than one, no matter what strong germicides are used. The whole area

of operation is well rubbed with soap, carefully shaved, and scrubbed with a sterile nail-brush and water as hot as can be borne. This scrubbing should be prolonged. Then the parts are covered with a compress dipped in 1 in 25 carbolic solution, which is left on for two hours, when the lower abdomen is covered with sterile wool until the next washing in the evening, and again the same process is repeated next day. By such means not only has the carbolic lotion time to penetrate into the follicles of the skin, but the latter are stimulated by the heat and friction to extra excretion which carries out the bacteria to the surface. As these radical cures are operations 'of choice', it is easy to spend some days as a rule over the cleansing of the skin.

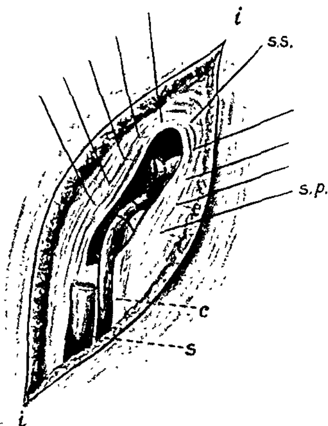


FIG. 254. AUTHOR'S METHOD OF RADICAL CURE OF INGUINAL HERNIA FOR CHILDREN. *i, i*, Incision in the skin. Sac tied off above by one suture, *s.s*, which is carried through the pillars of both rings and is ready to be tied on the external oblique. The lower part of the sac, *s*, is left open. Sutures, *s.p.*, carried through the pillars of the ring in front of the cord, *c*, ready to be tied.

AUTHOR'S OPERATION

The usual oblique skin incision having been made and the external ring exposed, the sac is separated from the cord with due respect for the vas deferens, which in the child is slender and easily torn. The sac is then drawn out of the abdomen and opened to see that it contains no gut or omentum. It is then transfixed as high as possible, tied completely round, and cut across below the ligature, the lower part being left to itself unless it is so small that its fundus comes away easily. With large inguinal herniæ I have always thought it a mistake to dissect the sac out of the scrotum. To do so costs some time, and a raw cavity is left in the scrotum which is apt to fill with blood, and this may give

trouble. If the sac be simply cut across and left *in situ* with its upper end open, it simply shrinks up round the testis in congenital cases and in acquired forms soon becomes lost in the tissues. The fears that it will form a hydrocele are much exaggerated if its upper end is left unclosed. The ligature which closes the stump of the sac is left long. One of its ends is now threaded into a Liston's curved needle and, guided by the finger thrust into the inguinal canal in front of the cord, is carried up the canal as far as possible and made to pierce the conjoined tendon high up from behind forwards, on the inner side of the ring and the aponeurosis of the external oblique. Here it is unthreaded. The other ligature of the sac is then threaded in the needle and, similarly guided, is passed through the posterior border of Poupart's ligament high up, and brought out through the external oblique. When these two threads are now drawn upon, the stump of the sac is pulled up into the abdomen, and, when they are tied, is fixed within the internal ring (see Fig. 254). In the same way the pillars of the external ring with the edges of the internal ring are drawn together by three or four sutures similarly placed in position by means of a Liston's needle, and the operation is finished by closing the skin wound.

The theoretical objections to this method are that the two rings are closed by the same suture, and that the cord leaves the abdomen through the internal angle of each. There is, therefore, an absence of the normal valve-like action of the deeper layers of muscles in which the internal ring lies, and consequently both rings correspond. But my experience of the method in children leads to the conclusion that this defect is not a serious one, and I have seen many patients dealt with by this method quite free of recurrence years after operation. The practical difficulties of placing the sutures in the pillars of the ring in children are easily overcome. But, as already remarked, this operation is less suitable for adults, on whom I prefer, as a rule, to do Bassini's operation.

KOCHER'S OPERATION

In this procedure an attempt is also made to utilize the sac in a way to reinforce the structures which defend the two rings, which in most cases are thinner than in the normal subject.

After the usual incision through the skin, the sac is separated completely from the cord and scrotum A small slit is then made through the external oblique just outside the position of the internal ring. Through this a pair of slender toothed forceps are inserted and pushed down the inguinal canal and out of the external ring (see Fig. 255). Here

they are made to take hold of the fundus of the sac and are withdrawn, bringing the latter with them through the slit described (see Fig. 256). When all the sac has been drawn tight through this hole it is twisted on its long axis (see Fig. 257) and is thus shortened. Silk ligatures are then carried through the pillars of the internal ring in front of the cord, guided by the finger in the canal, and through the external oblique. The twisted

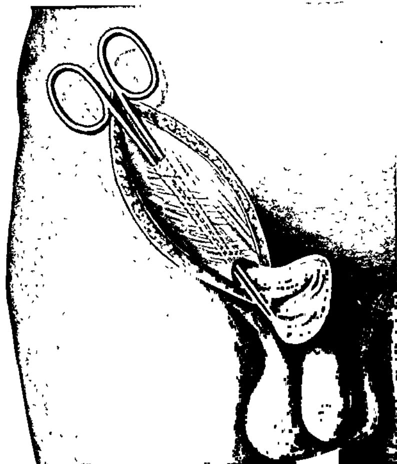


FIG. 255. KOCHER'S OPERATION. *First stage.* The external oblique exposed and a small slit external to the situation of the internal ring made for the insertion of slender-toothed forceps with which to catch the fundus of the sac previously dissected free.

sac having been now laid down between each row of these stitches, the latter are tied *seriatim* over the twist (see Fig. 257), after which the external ring is closed in the same way over its lowermost end.

This operation, too, has given very good results, but has the same defects as the last, inasmuch as it does not bring the conjoined tendon down *behind* the cord so as to reduce the size of the internal ring *from within outwards* and bring it into its old position, and so reconstruct the oblique inguinal canal. Closed as here described by stitches which must

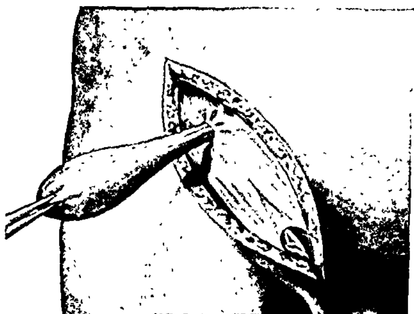


Fig. 256. Kocher's Operation. *Second stage.* The aponeurosis of the ternal oblique exposed and the sac drawn out through a small slit in it external the situation of the internal ring.

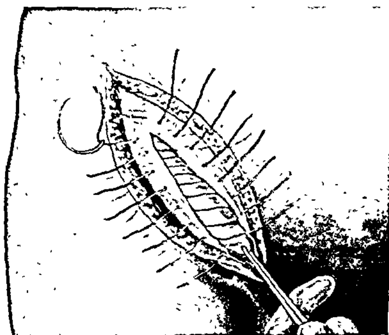


Fig. 257. Kocher's Operation. *Third stage.* Sac shown twisted over th situation of the canal; sutures passed through the pillars of the rings ready to b tied across the twisted sac.

pass in front of the cord, each ring will lie directly over the other without either being defended, the internal by the support of the overlying external oblique, and the external by the underlying conjoined tendon. If, however, the stitches be carefully passed through the pillars of both rings and tied over the twisted sac, the support of the latter may compensate for this defect. There is a risk, however, that the sac, separated from all its vascular supply and strained by twisting as well as strangled by the stitches including it, may lose its vitality and necrose and come away, or at least delay union until disintegrated. And this is stated to have occurred, though I have not seen it in the few cases in which I have employed the method. If the sac be very large, only the upper part of it need be twisted up to form the pad as described, the lower portion being left undisturbed in the scrotum. This avoids much unnecessary dissection, and the chance of a hæmatoma forming in the loose tissue of the scrotum (see p. 255).

BASSINI'S OPERATION

This procedure, which is now so widely done all over the world, derives its value from the fact that it, perhaps more nearly than any other, restores the structure of the inguinal ring to its original condition. In other words, it aims at reducing the enlarged internal ring from within outwards by stitching the conjoined tendon down to the posterior part of Poupart's ligament behind the spermatic cord. This can only be accomplished by first slitting up the external oblique aponeurosis from the external ring outwards and upwards to a point above the upper border of the internal ring.

The skin incision is the usual one for all these operations, and should expose the aponeurosis of the external oblique at once. The external ring having been defined without too much clean dissection, *which is unnecessary and only damages the vascular supply and general vitality of the parts to be closed*, one blade of blunt-pointed scissors is thrust through the ring under its internal pillar, and the aponeurosis is divided in a direction upwards and outwards until the upper border of the internal ring is exposed (see Fig. 258). It seems better to me to do this with a scissors than a knife, and, in directing the scissors, to keep well above the axis of the inguinal canal. In this way the intercolumnar bands are not cut as they cross the thinnest part of the aponeurosis of the external oblique, which, as is well known, is that directly over the inguinal canal. Moreover, when the external oblique comes to be stitched again there is thicker material to hold the stitches, and the two rows of sutures—the one drawing the conjoined tendons down to the posterior border of Poupart's

ligament, and the other drawing the divided external oblique up towards the outer border of the rectus—do not lie one over the other. This, to my mind, contributes to the strength of the barrier erected by the operation to the redescent of the hernia.

When the external oblique is thus divided, it is turned downwards and held by a pair of catch-forceps. The sac is now exposed, escaping from the enlarged internal ring, having the spermatic cord behind it. From this it is separated at the highest point possible, for two reasons. Firstly, it is usually very loosely attached to the cord at the abdominal part of the neck, and, secondly, when tied off there should be no dimple or pit left in the peritoneum opposite the internal ring. Before it is transfixed and tied, the neck of the sac should be carefully opened below the point selected for ligation, to see if it is clear of bowel and omentum. Either may be adherent and require separation or excision. Excision of the prolapsed and adherent intestine should of course only be attempted where the separation of very extensive adhesions would imperil the integrity of the tube or would leave such a large raw surface as to almost certainly cause wide readherence of a dangerous form on the return of the bowel into the abdomen. From what I have seen in many cases, I feel sure that resection in healthy bowel below and above the tangled mass is safer practice in many cases. But here the judgment of the operator is the determining factor. If familiar with the details of enterectomy in all its varieties, the risk will be small. I can recall several cases where, after separating very extensive adhesions, it was perfectly obvious that the condition of the gut was such that it ought not to be put back into the abdomen, and where I have removed the whole damaged parts, in one case including the cæcum, with the best results. But if, on opening the neck



FIG. 258. BASSINI'S OPERATION. *First stage.* Aponeurosis of the external oblique slit up and the sac removed; the cord leaving the upper angle of the internal ring is held up on a hook. The two deeper muscles and the fascia transversalis are seen.

of the sac, it were seen that the gut was hopelessly adherent to it over a large area, while the entering and leaving portions were sound, it would be better and safer at once to join the latter, end to end, leaving the adherent part to be taken away with the sac. This would besides save much time and oozing. (See Fig. 246, which represents the parts removed for these reasons in a case of large irreducible femoral hernia, the patient making an excellent recovery.)

Where the omentum is found adherent widely when the sac is opened, the simplest course to pursue is to draw it out a little further, tie it off, and reduce the non-adherent stump and close the neck of the sac. The lower part of the latter is then removed with the adherent omentum as a whole, the adhesions being left undisturbed.

If the adhesions exist in the upper portion of the sac, this part only need be removed, the lower part being left undisturbed in the scrotum. The presence of this portion there can have no influence upon the radical cure, and to remove it leaves a raw cavity in the lax tissue of the scrotum, in which blood and serum are apt to accumulate. But it is well to remove in all cases the upper part of the sac, which has been freely exposed and manipulated in the course of its separation from the cord. This part may have its nutrition impaired by the dissection, and may possibly have been infected from exposure. As it is free, then, it had better be divided below as far as detached, and so far removed. The mouth of the fundus should be left unstitched. If fluid accumulates in it, it can escape into the areolar tissue of the scrotum and be absorbed.

The most important part of the operation presents itself now, *i.e.* the drawing down of the conjoined tendon to Poupart's ligament behind the cord. This is lifted on double hooks and held well up until it is clearly strained against the upper border of the internal ring, the fibres of which are stretched on either side of it. A thread is now carried with a curved needle from behind forwards through the deepest part of Poupart's ligament, where it arches over the femoral vessels, coming out, of course, on the *inner* aspect of the aponeurosis of the external oblique, which was originally turned down after division (see Fig. 258).

The same thread is also carried under the inner border of the internal ring, taking up a considerable amount of tissue, which at this level will be mostly muscular. For this first stitch should be placed as high up close to the cord as possible, so that when knotted the cord is embraced closely. Similar stitches are now inserted, at about three-eighths of an inch from one another, through the same structures, from without inwards, until close to the spine of the pubis. The more internal ones, of course, take up the fibrous part of the conjoined tendon. When these are *in*

situ, the wound is very carefully dried out, and each is tied in series, commencing from within by preference, though they may be tied as in Fig. 259. The conjoined tendon is thus drawn down to the *posterior* border of Poupart's ligament behind the cord. The stitches should not be closed too tightly. If this is done they may strangle the included tissues and cause necrosis, though perfectly aseptic. All that is wanted is to bring the structures lightly together.

The flap formed by division of the external oblique is now laid down over the cord, which has been replaced on the sutured conjoined tendon, and is stitched at the same intervals until only room is left for the cord through a reduced external ring (see Fig. 260). The skin wound is then united in the usual way, and without drainage in the vast majority of cases.

A few details deserving notice may be specially referred to now. When the external oblique is divided as above, a good deal of fat will often be encountered around the cord and sac and continuous with the subperitoneal fat. This should always be removed. Again, any varicose veins in the cord had better be excised, so as to reduce the bulk of the latter. But during all this manipulation the greatest care should be taken not to crush or drag the vas deferens, which is easily damaged, more particularly in children, in whom it is especially fragile. Nerves and arteries, if seen, should also be turned aside without injury. The fibres, too, of the deeper muscles, which loop over the cord and sac in the formation of the cremaster muscle, should also be carefully separated and used in the act of suturing to strengthen the new barrier. Finally, each layer should be carefully dried out and freed from clots before the sutures are tied *seriatim*. For it is clear that one of the most important elements in securing a true radical cure is perfect flawless union by first intention.

The simplest aseptic gauze dressing padded with cellulose wadding is the best, secured by soft gauze rollers. The latter should include the whole scrotum and hold it up firmly against the pubis. The object of this is to prevent oozing into the scrotal tissues, which is very apt to take place if they are unsupported. The reason is obvious. The veins of the cord, even if not removed, are nevertheless more or less obstructed above by the tight suturing of the internal ring round them, and of course this encourages bleeding from any small divided venules in the root of the scrotum. But if the dissection be limited to the latter and the fundus of the sac be left *in situ*, firm pressure of the scrotum by the gauze rollers will prevent any trouble of the kind.

The *after-treatment* is simple. The wound will not require any attention for a week or ten days if properly done. In the meantime

there may be pain and some distension for twenty-four hours, due to the reluctance to exert the abdominal muscles and expel flatus. This is as a rule relieved by an opiate, which, allaying pain, enables the patient to disperse the wind. Retention of urine is common at first, probably for the same reasons, but is relieved in the same way. The catheter, however, may be necessary at first. Diet should be light until the bowels are moved by enema at the end of a week. The patient should, if possible, be kept recumbent for three weeks in order that the plastic

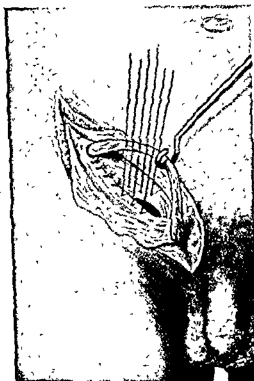


FIG. 259. BASSINI'S OPERATION. *Second stage.* The two deeper muscles partially sutured from without inwards under the cord.

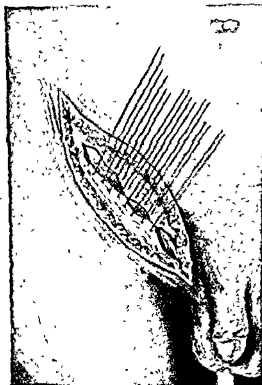


FIG. 260. BASSINI'S OPERATION. *Third stage.* The aponeurosis of the external oblique partially closed over the cord.

changes may be soundly completed. But in older patients with a tendency to chest and bladder complications, it is well to let them out of bed a little earlier, or even a few days after operation. In any case, all these patients of advanced age should sit up in bed from the first, to avoid hypostatic troubles in the lungs, and should by all and every means be sustained in general strength.

The results of this operation when well done are excellent and have probably never been excelled. It is anatomically sound and easy to execute, but attention to detail is particularly essential, and a clear conception of the objects in view.

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(see Fig. 261) to facilitate the introduction of the six or eight deep mattress sutures, which pass through the aponeurosis of the external oblique and through the internal oblique and transversalis muscles and fascia transversalis on one side, and through the fascia transversalis and Poupart's ligament and fibres of the aponeurosis of the external oblique muscle on the other.



Fig. 262. Halsted's Operation. *Second stage.* The aponeurosis of the external oblique is shown drawn together beneath the cord which comes out in the upper angle of the wound lying under the skin.



Fig. 263. Halsted's Operation. *Third stage.* The skin partially closed over the cord.

The two outermost of these deep mattress sutures pass through muscular tissues and the corresponding tissues on both sides of the cord. They are the most important stitches, for the transplanted cord passes out between them. If placed too close together the circulation of the cord might be imperilled, and if too far apart the hernia might recur. They should, however, be near enough to each other to grip the cord (see Fig. 262). The precise point to which the cord is transplanted depends upon the condition of the muscles at the internal abdominal ring. If in this situation they are thick and firm and present broad raw surfaces, the cord may be brought out here. But if the muscles are attenuated at

HALSTED'S OPERATION

This operation was originally described by its author as nearly identical with Bassini's. But in a more recent communication he has pointed out and illustrated several modifications which he believes have added to its value and which must be briefly alluded to here.

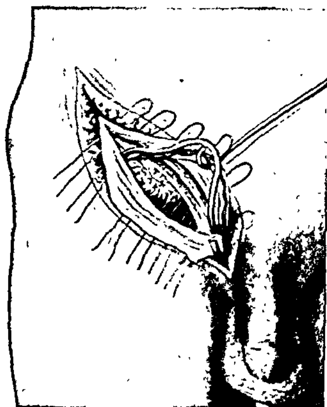


FIG. 261. HALSTED'S OPERATION. *First stage.* Shows the aponeurosis of the external oblique slit up, the cord and small veins held up on a hook, the large veins having been cut away. The sac has been removed and its peritoneal opening closed. *Mattress sutures are seen passing through the two deeper muscles ready to be tied.*

In his first account he states that he makes a new canal and new rings. When the aponeurosis of the external oblique is exposed by an incision of like direction, but rather longer than for most other methods, the *three* abdominal muscles and the fascia transversalis are cut through from the external ring to a point about 2 cm. above and external to the internal abdominal ring. The vas deferens and the blood-vessels of the cord are isolated. All but two or three of the veins are excised. The sac is carefully opened and its contents are replaced, and it is closed by suture so as to leave no pouch of peritoneum and cut away beyond the line of sutures. The cord in its reduced form is raised on a hook out of the wound

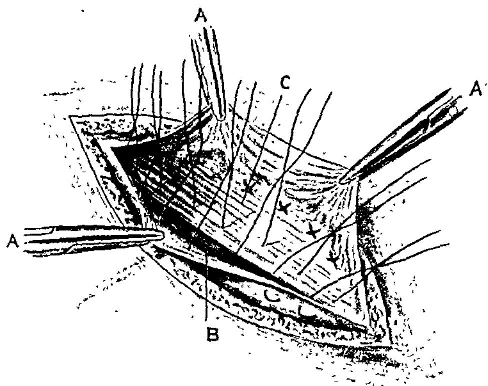


FIG. 265. HALSTED'S OVERLAPPING METHOD. A, A, A, As in Fig. 264; B, Poupart's ligament, to which the internal oblique, C, is being drawn down over the cremaster layer by mattress sutures; C, Internal oblique muscle.

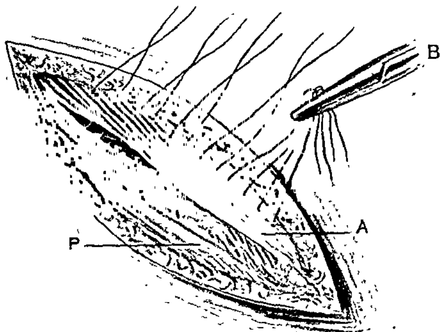


FIG. 266. HALSTED'S OVERLAPPING METHOD. A, Lower leaf of external oblique muscle being drawn under the upper leaf by mattress sutures, B; P, Poupart's ligament.

this point and present thin cut edges, the cord is transplanted further out. The skin wound is brought together by buried skin sutures of very fine silk (see Fig. 263). The transplanted cord lies on the aponeurosis of the external oblique muscle and is covered by skin only where it may be felt (see Figs. 262, 263).

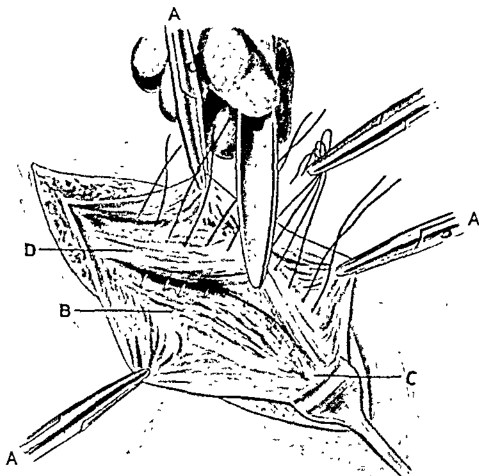


FIG. 264. HALSTED'S METHOD OF OVERLAPPING THE VARIOUS LAYERS INVOLVED IN OPERATIONS FOR RADICAL CURE OF INGUINAL HERNIA. A, A, A, Forceps holding apart the split external oblique aponeurosis; B, Cremaster layer with mattress sutures drawing it under the edge of the internal oblique muscle; C, Spermatic cord; D, Internal oblique muscle.

In this last feature lies the chief distinction between Halsted's operation and Bassini's method. In the first all three muscles are divided to make a new internal and external ring at one spot above and outside the old ring, and the spermatic cord becomes a subcutaneous structure in the fold of the groin. The inguinal canal and both old rings are obliterated by the method of suture and no longer contain the cord This was claimed as an advantage, but it is open to question whether

THE USE OF WIRE NETWORKS FOR INGUINAL HERNIÆ

In some inguinal herniæ with large rings and weak muscles and thin aponeuroses, or where some destructive suppuration has been the origin of the weakness, it is quite clear that we cannot hope to erect a sufficiently solid barrier to re-descent by any of the simple suture methods described above. In such, a recurrence is often likely to follow sooner or later, unless some measure for reinforcing the sutured structures be adopted. Here the use of wire networks will yield the best results. The presence of the spermatic cord in these herniæ requires some modification of the form of the network already described (see Fig. 251, p. 577) and of its arrangement in the tissues. The objects in view will be to support the internal ring where the cord is leaving it, and also the external ring where the cord is escaping from it to enter the scrotum. With this end in view I make my networks, as it were, bifid at both ends and not so broad as for umbilical or ventral herniæ. Their length must be roughly estimated beforehand by measuring from the middle of Poupart's ligament to the spine of the pubis. Then taking a long piece of fine silver wire, No. 30 Imperial Wire Gauge, two loops about half an inch long are twisted at its middle and then successive loops on either side as in Fig. 269, until the whole is about two inches long, the last two loops having the arrangement seen in Fig. 269.

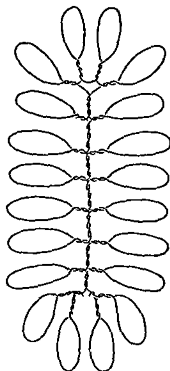


FIG. 269. WIRE NETWORK SUITABLE FOR INGUINAL HERNIA. The spermatic cord lies between the two upper and two lower loops. The size of the network would suit the largest individual, but for a smaller man it could with advantage be reduced in all dimensions. The size of the wire is correct. In Fig. 251 it is too thick.

When the stage of the operation (Bassini's) has been arrived at in which the conjoined tendon has been drawn down to Poupart's ligament, thus reducing the internal ring to its smallest dimensions and most external position (see Fig. 259), the network is laid down over the line of suture in such a way that its two upper loops lie one on each side of the cord as it leaves the internal ring. The cord is then laid down upon it and should lie below between the two lowermost loops of the network. Now the flap of the external oblique (see Fig. 260) is folded over the cord and stitched into its old position as already described. The cord and network are now lying between the two layers of abdominal muscles, the

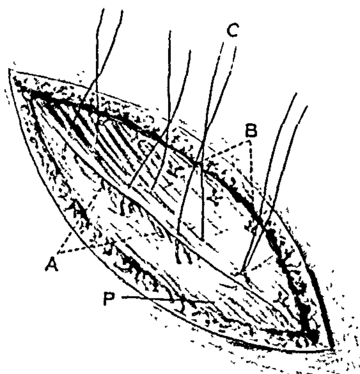


FIG. 267. HALSTED'S OVERLAPPING METHOD. A, Edge of the upper layer of the external oblique muscle being united to the under layer, B, by ordinary interrupted sutures, C, passing through its edge and through Poupart's ligament, P.

the defensive works now existing round the point of exit for the cord directly through all the muscles is as good as those surrounding the reduced rings in Bassini's operation.

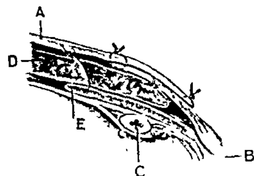


FIG. 268. THE ARRANGEMENT OF THE LAYERS WHEN THE OPERATION IS COMPLETED. A, Upper layer of the external oblique; B, Lower layer, C, Cord; D, Internal oblique; E, Cremaster.

The more recent modifications of his operation introduced by Halsted *are concerned with devices for* making the various layers of the structures round the canal overlap by different sutures so as to reinforce one another, and so add to the thickness of the barrier opposing the redescent of the hernia. These devices are best understood from his own original drawings, which are here copied by permission (see Figs. 264–8).

CHAPTER XVIII

OPERATIONS FOR THE RADICAL CURE OF NON-STRANGULATED FEMORAL HERNIA

ANATOMICALLY there are at least two varieties of these herniæ. The common form passes under Poupart's ligament internal to the femoral vessels, the sac of peritoneum lying on the pectineus muscle with a prolongation of the fascia iliaca interposed as well as the pectineal portion of the fascia lata and covered by the extension downwards of the fascia transversalis. These points, and the boundaries of the femoral opening through which the sac is forced from the abdomen, are the chief factors which concern us as operators, whether we are engaged in the relief of a strangulated hernia or are aiming at a radical cure of the condition.

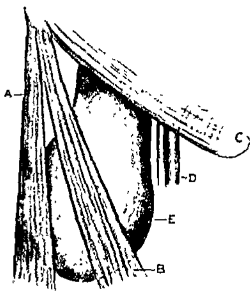


FIG. 270. FEMORAL HERNIA EXTERNAL TO THE ARTERY. A, Tensor fasciæ femoris muscle; B, Sartorius muscle; C, Poupart's ligament; D, Femoral artery and vein; E, Sac of the hernia.

But there is another form of femoral hernia passing underneath Poupart's ligament which, though rare, deserves to be described and kept in mind by all surgeons who interest themselves in the subject in hand. In this variety the sac, instead of being forced downwards into the groin to the inside of the femoral vessels, is protruded *external* to them and internal to the anterior superior iliac spine. The relations to the iliac and fascia transversalis are otherwise analogous to those in the common form and require no special description. Fig. 270, from a rough drawing which I made at the time of the state of things encountered in one of my own operations at University College Hospital (*British Medical Journal*, September 10, 1898), sufficiently exhibits the position of the hernia. Its only relation of serious import was the femoral artery.

latter deepest and supporting both the internal and external rings by its terminal loops, which project beyond where the cord enters and emerges between them. These terminal loops may be steadied by a tie of fine thread uniting them above and below the cord. When, after a short interval, the two layers of aponeurosis are united by lymph developing into fibrous tissue, there is no chance of the network shifting its place. I have not yet had the bad fortune to see suppuration form in a fresh wound where such a filagree has been inserted, but those who have assure us that there is no need to remove the silver wire, which, far from provoking irritation, is believed to have an antiseptic action, and ultimately becomes incorporated with the tissues.

OPERATION UPON INGUINAL HERNIA IN THE FEMALE

When an inguinal hernia occurs in the female, it usually follows the course of the round ligament through the unobliterated process of peritoneum partially covering that structure and known as the canal of Nuck. As the round ligament lies really outside the peritoneum but intimately connected with it, the canal cannot be completely isolated and tied off at its neck like an ordinary sac without such a minute dissection as would imperil the nutrition of the membrane. The choice, therefore, lies between cutting through the round ligament, which would be undesirable, or passing the thread through it immediately under the peritoneum and then round the freed portion, tying them both in one, and so obliterating the canal. This is undoubtedly the best course to follow. The closure of the internal and external rings is then effected on the lines of Bassini's operation (see p. 589). The round ligament need not in this case be treated as the spermatic cord would be in the male, but can be left in the internal angle of both rings.

by complete cure of the condition. And I have frequently seen such cases years later with no return of the hernia. This is not intended to imply that no further steps to close the femoral opening need be taken, but it gives us more assurance of a permanent result when the latter has been done. In other words, if the simple removal of the sac of the hernia with ligature of its neck, even where Gimbernat's ligament has been cut to release a constriction and where consequently the femoral ring has been enlarged and weakened, is enough in many cases to cure the condition, how much better ought to be the prospect in non-strangulated cases where Gimbernat's ligament is not cut and where the femoral canal is closed by stitching. It is now the practice, even in strangulated cases, unless there be serious contra-indications, to perform a radical cure at the time the obstruction is relieved.

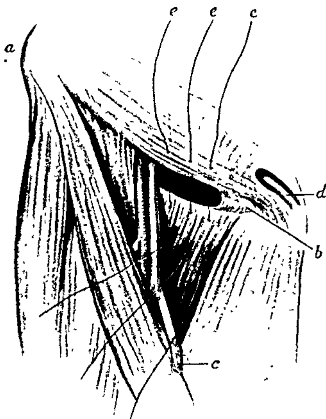


Fig. 271. Femoral Ring after the Sac of a Hernia has been tied and reduced. The sutures for closure of the ring, *e*, *e*, *e*, are in place. The first lies close to the femoral vein, the last lies close to Gimbernat's ligament, *b*. *c* is the saphena vein, and *d* the round ligament.

The usual preparation of the skin will in these cases of femoral hernia require to be carried out with the greatest care to secure asepsis in a part difficult to cleanse. Otherwise the operation which is usually practised is very simple. A vertical incision is made for about three inches with its centre over the neck of the sac and Poupart's ligament. Through this the sac is easily reached after dividing the usual superficial fat and fasciæ. A few sweeps with a blunt elevator soon enable us to lift up the whole sac with its contents and define the neck. This is very cautiously opened and the contents reduced if non-adherent. If there be adherent omentum it is better to pull a little more of it down, tie it off, and remove the attached portion with the sac. If gut be extensively fused with the sac, *i.e.* to such an extent that the

Neither the femoral vein, epigastric, nor irregular obturator artery had any relation to it, and it was easily cured by removal of its sac and stitching down Poupart's ligament to the muscle and fascia underneath on the same principles followed in the common variety. The contents of femoral herniæ are as a rule small, and less frequently large, intestine (see Fig. 246). But it is well for the operator in every case to bear in mind that occasionally the bladder has been found in such herniæ, and if not recognized before or during the operation may be injured and cause fatal extravasation of urine. The ovaries have also been met with in rare cases, and if tightly caught give rise to intense pain and tenderness. Another condition which has been mistaken for a prolapse of the ovary, and the symptoms of which closely resemble those accompanying the latter, is the retention within the femoral sac of a portion of omentum which has become fibrous and developed cysts in its substance. Such a mass is usually remarkably sensitive to pressure, and, indeed, when exposed at an operation looks at first sight very like an ovary, the resemblance being the closer from its attachment to a broad peritoneum-covered pedicle. As these have to be removed it is necessary to examine them closely beforehand. Again, it must be remembered that the cæcum and the sigmoid flexure have been found in femoral herniæ in rare instances. In such cases it must be borne in mind that the bowel will be uncovered by peritoneum over a considerable area, as in the case of prolapse of the organ into an inguinal hernia (see p. 582). This will require a modification of the treatment of the sac. As a rule, when it is discovered on opening the sac that one or other of these viscera is present, the opening must be closed at once and the whole sac stripped out of its bed and reduced with the gut before the operation is proceeded with. In Fig. 246 it was supposed at first that the cæcum formed the strangulated portion, as the vermiform appendix was in the sac and the bowel seen was very large and rough on its posterior surface. This was, however, ultimately recognized to be the last part of the ileum, greatly dilated and covered by adhesions, with the appendix lying upon it. It will be seen that the strangled mass on removal at the operation did not quite include the cæcum, but this had to be removed with it.

METHODS OF OPERATING

This has always appeared to me a much simpler problem than the prevention by operation of the descent of an inguinal hernia. Some years ago, before radical cures were attempted *after the relief of strangulation*, I was struck by the fact that the mere ligature and removal of the sac without any attempt to close the ring was frequently followed

by complete cure of the condition. And I have frequently seen such cases years later with no return of the hernia. This is not intended to imply that no further steps to close the femoral opening need be taken, but it gives us more assurance of a permanent result when the latter has been done. In other words, if the simple removal of the sac of the hernia with ligature of its neck, even where Gimbernat's ligament has been cut to release a constriction and where consequently the femoral ring has been enlarged and weakened, is enough in many cases to cure the condition, how much better ought to be the prospect in non-strangulated cases where Gimbernat's ligament is not cut and where the femoral canal is closed by stitching. It is now the practice, even in strangulated cases, unless there be serious contra-indications, to perform a radical cure at the time the obstruction is relieved.

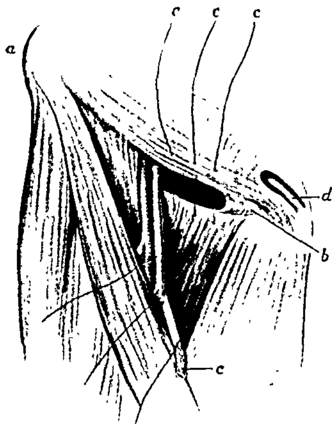


FIG. 271. FEMORAL RING AFTER THE SAC OF A HERNIA HAS BEEN TIED AND REDUCED. The sutures for closure of the ring, *e*, *e*, *e*, are in place. The first lies close to the femoral vein, the last lies close to Gimbernat's ligament, *b*. *c* is the saphena vein, and *d* the round ligament.

The usual preparation of the skin will in these cases of femoral hernia require to be carried out with the greatest care to secure asepsis in a part difficult to cleanse. Otherwise the operation which is usually practised is very simple. A vertical incision is made for about three inches with its centre over the neck of the sac and Poupart's ligament. Through this the sac is easily reached after dividing the usual superficial fat and fasciæ. A few sweeps with a blunt elevator soon enable us to lift up the whole sac with its contents and define the neck. This is very cautiously opened and the contents reduced if non-adherent. If there be adherent omentum it is better to pull a little more of it down, tie it off, and remove the attached portion with the sac. If gut be extensively fused with the sac, *i.e.* to such an extent that the

separation from it would leave the surface of the bowel in a ragged, raw condition, it is better, in my opinion, to remove the loop of bowel and anastomose it end to end. Some years ago, in a case with which I had to deal, I found this condition of things in a very marked degree, and was obliged to draw down a foot or two of intestine and remove it, as it could not be reduced in a sufficiently sound state to be safe. The patient made an excellent recovery. Fig. 246 represents the parts removed, consisting of the cæcum and last part of the ileum, which are now preserved in our Museum, No. 1599 A. But neither the bowel nor intestine is likely to be seriously adherent in an ordinary case of femoral hernia. It is therefore only necessary to transfix and tie off the neck as high as possible and cut away the sac below.

The next step consists simply in drawing down Poupart's ligament to the pectineal portion of the fascia lata. This is best done with a *Liston's needle armed with No. 60 linen thread. The left forefinger is* placed in the femoral ring with its pulp against the femoral vein. The needle held in the right hand is now passed from below upwards through the fascia and underlying pectineal muscle, entering about an inch below the pectineal line and coming out close to the latter as near to the finger-nail as possible. The needle is then made to cross the femoral canal and pierce Poupart's ligament from within outwards (see Fig. 271). It is then unthreaded and withdrawn, leaving the thread *in situ*. Two or at most three other sutures are similarly placed internal to the first at about a quarter of an inch from one another. When these threads are individually drawn moderately tight and tied, Poupart's ligament is drawn downwards and the fascia and muscle tissue upwards, closing the femoral canal. The skin wound is then closed and dressed in the usual manner and should heal under one dressing. The only danger likely to arise in this operation is wound of the femoral vein during the introduction of the first needle. But this is avoided by pressing the vessel outwards with the finger. I cannot remember a case in which I have seen evidence of its being wounded. The results of this simple operation have in my experience been excellent. I am unable to recall an instance in which recurrence has taken place.

CHAPTER XIX

GENERAL CONSIDERATIONS REGARDING OPERATIONS FOR STRANGULATED HERNIÆ

MUCH depends, as regards what should be done in any particular case, on a true appreciation by the operator of the condition of the strangulated bowel with which he has to deal. He may have in one case bowel which is practically unaltered by the strangulation and which he can return into the abdomen with perfect safety, and in the next a condition of sphacelus which absolutely forbids such a course. Between these extremes there are many degrees of damage to the intestine and the system generally, and it requires the nicest discrimination, based upon pathological knowledge and experience, to determine the course to be pursued. The old distinctions between incarceration of bowel and strangulation have at the present day very little practical value. All modern surgeons recognize the necessity of operating on both forms, and of relieving patients of conditions which are either immediately dangerous to life or almost certain to become so sooner or later.

It is impossible here to describe in detail all the ways in which strangulation of a portion of intestine may be injurious to the bowel locally, and to the system generally. But it is necessary as a basis of action to consider in outline some of them which most concern us in operating.

The first symptom of the protrusion of a portion of intestine or omentum covered by the parietal peritoneum through a narrow opening in the abdominal wall such as is the most likely to produce strangulation, is *pain*. This pain is apparently due to two causes. Firstly, there is in some cases of large herniæ a strong drag upon the mesentery and higher omentum, which are to a certain degree themselves supplied with sentient nerves (while the actual bowel is practically insensitive), but which through their reflections pull upon the highly sentient parietal peritoneum, which is richly supplied with sensory nerves and their end organs. Secondly, there is the strain and pressure of the protrusion upon the peritoneum in and about the hernial aperture. In the case of a small protrusion which does not drag on the mesentery or omentum, the pain is apparently due to the drag on the peritoneum alone in and about the ring. Various observations, clinical, anatomical, and histological, might be cited in support of these views if space permitted.

They will be found in the recent publications of Lennander, Dogiel, and Ramström, and to my mind they are convincing. The illustrations of the last two authors' works are most beautiful.

In addition to pain there is in many cases *shock*, especially where large protrusions take place through relatively small openings. This shock is due to the same impression on the nerves, and is in proportion as a rule to the tightness of the constriction and suddenness of onset. In old herniæ neither pain nor shock is as a rule marked. In both old and recent ruptures they are at once relieved by reduction.

The next effect noticed is *local tenderness* over the hernia itself, due to the strain on the peritoneal sac by the protrusion first, and subsequently to irritation and the effusion of serum or inflammatory products. This effusion commences usually very early, and may be said to be in proportion to the bulk of the extruded viscera and the tightness of the constriction.

The cause of the effusion is in the first place pressure on the veins of the protruded viscera while the arteries are still pervious. Later, when these arteries become so pressed upon as to be occluded, certain vital changes begin in the mass which end in inflammation and the accumulation of its products, not only within the sac but also in the walls of the bowel and its lumen. It is now well known that the intestinal bacteria do not pass through undamaged bowel-wall, but that when the latter has its vitality lowered up to a certain point in any way, they pass through mucous, muscular, and ultimately the serous coats readily. It is therefore found that up to a certain period after strangulation the fluid of the sac, however abundant, is sterile, but that, if the constriction persists, a time comes when septic bacteria are found in it which have wandered out from the contents as the result of damage to the coats of the bowel. As the result of this infection we have, in milder cases which recover with or without reduction by taxis or open operation, more or less adhesions, transient or permanent. In the graver cases we find every degree of inflammation, up to local or general sphacelus of the bowel, sac, and overlying soft parts.

But besides these effects on the hernia itself there are other sequelæ, far graver, inasmuch as they imperil the health of the whole body. These are the changes which take place in the intestine *above the seat of the constriction.* In reviewing them it is well to consider first the alterations which take place within the lumen of the bowel, and then those which are observed in the walls of the same.

When complete obstruction has been brought about, it is obvious that there must be an accumulation of fæces, mucus, and gas in the part of the intestines proximal to the constriction, to a varying height. In

this material putrefaction advances rapidly, with the multiplication of countless bacteria of various kinds. The toxins of these become sooner or later very abundant, and at last begin to be absorbed not only locally but generally, and to exercise the most baleful effect upon the organs and tissues of the body, especially the lungs and kidneys. The well-known clinical effects often seen ultimately are fever, broncho-pneumonia, and albuminuria. Doubtless the lung troubles in these cases are more or less initiated and aggravated by the entrance into the air-passages of traces of putrid materials which are vomited up sooner or later after the onset of the strangulation. The amount of festering material in a strangled portion of bowel is sometimes enormous, amounting to many pints—one foot of intestine with a diameter of 2 inches will hold about one pint—it is made up not only of the original contents of the bowel, but of much mucus and serum poured out by the irritated bowel. That it is intensely irritating is well seen in those cases in which, for one reason or another, an artificial anus has been made into a piece of bowel so charged. Here the contents escaping first are seen to be fluid, and not only feculent but mixed with mucus and blood-stained. Within a very short time the skin around the opening is intensely inflamed over the area exposed to the liquid discharges from the bowel. And it may take days or weeks, if the patient survive, for the discharged material to return to the characters of normal fæces and so to lose its irritating qualities. Bacteriological investigation has shown that this decrease in irritating qualities runs *pari passu* with a decline in the number of organisms present in the fluid. For instance, one platinum loop-full has been shown to yield innumerable colonies of bacteria in a cultivating medium when taken from the first discharge. A day or two later they are fewer; later on they can be counted, and at later intervals they may become rare, and even disappear altogether if the patient be given sterilized food and special care be given to the antisepsis of the mouth (Cushing). The general effects of this loading of several feet of distended gut with toxic material are therefore easily realized, and can be seen in most of these cases without difficulty. The patient looks ill and depressed. The colour generally is bad, the tone of the skin being earthy or dirty, perhaps greasy. The temperature is raised, and the pulse is growing rapid and losing tension. The abdomen is not only distended but tender over the affected coils, and this usually indicates commencing peritonitis. There is nausea and stercoraceous vomiting, and not infrequently incipient bronchitis or pneumonia. The urine will often contain albumen as the result of the toxæmia.

The local effects upon the bowel above an obstruction are also easy to see in cases operated on. Besides being distended in a degree increasing

as the point of obstruction is approached, it appears in acute cases thinner in substance, while in more chronic conditions its walls are thicker, in part owing to hypertrophy but (in cases which have survived acute obstruction for some time) also in part to an œdematous condition of the coats, due to inflammation starting from within. The colour is changed from every degree of injection in mild cases, and at a distance above the obstruction, to deep purple, merging almost into black where gangrene is setting in. Part of the deeper colour is due in some cases to effusion of blood into the lumen and submucous coats of the bowel from rupture of small eroded or thrombosed vessels. All these conditions may be present without any evidence of the presence of lymph on the peritoneal surfaces. But in neglected cases this will appear, and indicates a very desperate condition of things. Besides these changes the discoloured distended tract of bowel has lost all its vermicular movement and contractility. It is simply distended owing to paresis or complete paralysis of its muscular coats.

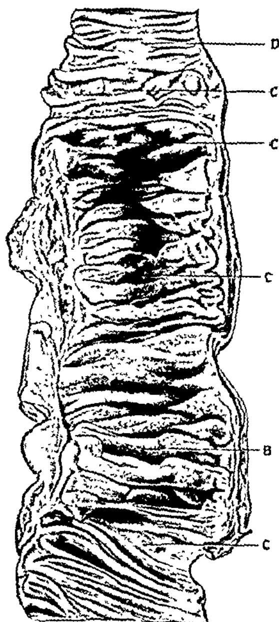


Fig. 272. Portion of Small Intestine from above a severe Strangulation. D, Uppermost portion almost healthy; B, Spot nearer the constriction below shows congested abraded mucous membrane; C, C, C, Showing ulcerated spots where the mucous membrane of the bowel has been destroyed. (*From Museum of University College Hospital Medical School.*)

When such a portion of bowel removed from the living body is laid open from the point of obstruction upwards, the tissue changes can be better interpreted (see Fig. 272). Immediately above the obstruction is the area of greatest distension, and here the mucous membrane is thickened by œdema, discoloured by ecchymoses, and softened, if not actually

ulcerated. From this point upwards all these changes gradually decrease until, some feet above, the conditions are beginning to approach the normal. But more than once I have found considerable œdema and discoloration 5 and 6 feet above the constricted loop, as in the case from which the specimen (see Fig. 272) was removed.

These changes are easily explained. In the first place, we have the forcing of the healthy bowel above, pumping loose matters against the obstruction and mechanically distending the tube above the latter to its utmost capacity. Then there is the bacterial fermentation and the production of gas and irritating toxins, which soon give rise to œdema. Into the mucous membrane thus lowered in vitality the bacteria now migrate and colonize, thrombosing and destroying small vessels and leading to rupture and ecchymoses, and ultimately to ulceration. Sooner or later the bacteria reach the outer tunics of the bowel, and give rise to localized or general peritonitis, even without any perforation. The presence of toxins and their effects on the muscle and nerve tissues in the coats of the bowel also explain the paralysis, which sooner or later is complete, and often, even where the obstruction is relieved comparatively early, remains in some degree permanent. In opening the abdomen of patients on whom some years before I had performed enterectomies for obstruction, I have several times found that the bowel, for a considerable distance above the point affected, *still* showed signs of marked paresis. These cases have been recorded (*Lancet*, April 22, 1905).

All these changes, physical and vital, have to be kept in mind when we are dealing with strangulated herniæ, and a proper appreciation of them will lead to improved technique during the operation, and more rational after-treatment. Our chief difficulty lies in estimating in each case how far these changes have progressed. The actual time which has elapsed since the strangulation commenced is not a sufficient guide. Some herniæ which have only been down for a few hours are often in a worse condition locally than those which have been strangulated for some days. Nevertheless, time has to be taken into consideration, and gives us a certain amount of guidance as to what we may expect in the bowel above the constriction and in the system generally. Nor does the situation of the hernia always determine the condition of strangulation reached in a given time. But it may be stated generally that the tight fibrous femoral ring is more likely to seriously strangle a loop of gut than the looser inguinal. The most reliable guides to the condition likely to be met with are derived from a consideration not only of the duration of the strangulation, its position, and state of tension, but of the patient's general physical condition, habits as to food, amount and character of the

matters vomited, *pulse*, temperature, and general appearance. Passing all these in review one is able, after a large experience, to make a tolerably accurate forecast of the condition likely to be found, not only in the strangled loop itself but in the proximal part of the bowel for several feet upwards, which is quite as important. Our prognosis in regard to the effects of operation is also based on these factors. But in any but the most recent strangulations every preparation must be made for a possible enterectomy which may be required for one reason or another. Of course in some *very recent* strangulations, especially among the extremely aged or infirm, it may be safer practice to attempt reduction of a hernia than to expose the patients to the risks incidental to a long operation as well as the rigorous preparation for asepsis and the prolonged general anæsthesia. But there can be little doubt that at the present day, in the average case, the dangers of operation, which are very small in good hands, are less than those of reduction of a portion of bowel, the vitality of which, as the result of severe strangulation, is unknown to us. Moreover, in operating, we have the extra advantage that in most cases a radical cure can be accomplished after the relief of the obstruction. The rule is therefore, now, to operate in every case of strangulated hernia, without attempting reduction by taxis, unless in the very aged and infirm with *very recent* and soft protrusions, or where the general condition is hopeless.

GENERAL PREPARATIONS FOR OPERATION

The preliminaries for such an operation are quite as important as the procedure itself, or rather are the most indispensable part of the whole undertaking for the relief of strangulation. Although touched upon before, they must be emphasized again here. They include, first, the cleansing of the skin in the most approved way. Both the pubic and inguinal region require more care in this direction than perhaps any other part of the body, on account of the great number, size, and depth of the hair and sebaceous follicles. In many of these cases the preliminary hot bath, which is the routine and can, moreover, be repeated on successive days before operation for *non*-strangulated hernia, is often inadmissible on account of the patient's general condition. But if it can be used it should be. In most cases we are restricted to local cleansing. The parts must, therefore, be first well soaked in hot water and soap, and then carefully shaved and washed again and again, and finally covered with a large compress dipped in 1 in 25 carbolic lotion for as long a time as the other preparations for the operation will admit of. Undue delay is of course undesirable in cases of strangulation, but a little is permissible in the interests of asepsis. At the same time, unnecessary chill or exposure of

the patient during the preparation must be guarded against, especially as it will be indispensable to include at least the lower half of the abdomen in the clean area, in view of a laparotomy being possibly necessary in complicated cases. Next, the washing out of the stomach must be practised as a routine, with a funnel and tube, until the water employed runs clean. This may perhaps sometimes be omitted if we are dealing with very recent strangulations, where the patient has vomited only bile-stained fluid after bringing up the last food taken. But otherwise it should be done as an established rule, and it is especially necessary to be thorough if the vomit has been stercoraceous. Some of the foul matter is sure to hang about the fauces and mouth in these cases, and every inhalation is capable of carrying septic matter into the lungs. There can be no doubt, then, that the thorough cleansing of the stomach, fauces, and mouth diminishes the risk of those lung troubles which we know from experience are so apt to follow long operations. In many cases, too, this washing may be repeated after the conclusion of the operation, during which regurgitation from the intestine into the stomach may have taken place. I have seen a basinful of foul fæcal matter removed while the patient was on the table immediately after an operation for obstruction, from a stomach which had been washed perfectly clean beforehand. It must not be forgotten, too, that this clearing out of the stomach gives the intestine below a better chance of that rest after operation which is so essential to its recovery.

In view of the fact that many of these operations are necessarily prolonged, especially if enterectomy becomes unavoidable, the body-heat of the patients must be maintained by every means possible. They should be swathed in warm wool from head to foot, whether lying on a heated table or not. If not, they should have hot bottles on either side of the body and between the thighs. And, further, the strength of the patient must be built up before, during, and after operation by every means in our power, not only because they have probably been unable to assimilate food beforehand, but also because they will often be deprived of nourishment by the mouth afterwards. For these reasons, to restore the loss of water from vomiting, from the lungs, skin, and kidneys, the hypodermic infusion of warm normal saline or 5% glucose solutions is desirable before, or during operation to save time, to the extent of at least half a litre or one pint, and this may be repeated afterwards with advantage. Warm rectal injections of normal saline ℥ x with brandy are also most useful, and subcutaneous injections of liq. strychninæ ♏ v, repeated from time to time. It is well to bear in mind also the great tendency to low broncho-pneumonia present in these cases. They should therefore be kept, after recovery from the *anæsthetic*, in a semi-

recumbent position in bed, and only allowed to lie down for sleep, and may be got out into an easy chair much sooner than is the general practice at present—often on the third or fourth day. The thorax should continue to be wrapped up in wool, and the back should be shampooed twice or oftener daily. In many cases early feeding by the mouth is quite justifiable and desirable, if the food be fluid and light, and such as to leave but little residue. In old or feeble patients stimulants are given with great advantage.

All these preliminary considerations have such an important bearing on the success of operations for strangulated hernia, and indeed for all cases of obstruction, that I have thought it indispensable to reiterate them here, before any description of the actual operative procedures themselves—though, indeed, they hold good for most serious operations of any kind.

CHAPTER XX

OPERATIONS FOR STRANGULATED INGUINAL HERNIA

Operation. Starting with the assumption that we have before us an inguinal hernia of the common form (see p. 580) in a condition of strangulation, the symptoms of which are not included in this article, we turn at once to the treatment by operation. (For the preparation of the patient see p. 610 *et seq.*)

In making the incision for strangulated inguinal hernia, it is well to remember that the less it involves the scrotal area the less chance is there of infection of the wound or stitches from the deep hair or sebaceous follicles so abundant in this region. The skin incision, therefore, may be described as running from a point at least an inch above and external to the internal inguinal ring, downwards and inwards over the neck of the sac to the root of the scrotum. It need not be very long, inasmuch as the areolar tissue is here so loose that in the further course of the operation the skin can be drawn in any direction, quite easily, to reach the deeper structures. All contact with the skin and operator's fingers, gloved or naked, should be avoided, and this is easily done by using sterilized instruments throughout the operation instead of fingers.

The neck of the sac is now defined by rapid dissection over its middle line, and for a couple of inches downwards, with due regard to the structures of the spermatic cord, which almost invariably lies behind the neck of the sac and may be injured by rough dissection. In all cases the sac should be opened, as only by this means can it be determined whether the gut is in a condition safely to be returned to the abdomen. The possibly infected sac fluid can also be evacuated and the bowel washed with sterile saline solution. The constriction, which generally lies in the external or internal inguinal ring, can now be divided outside the sac by passing under it a probe-pointed hernia knife and cutting upwards and inwards to as small an extent as possible, consistently with release of the bowel. Sometimes I have found it safer and easier to divide this constriction by means of blunt-pointed scissors, in successive snips from without inwards. If this method be adopted, there is less danger of wound of the epigastric artery than when the knife is thrust under the constriction and cuts towards the surface. Indeed, the division of the

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in which suppuration is apt to take place in this region. But in any case it is well to remove that part of the sac below the point of ligature which has been separated from its surroundings, exposed, and manipulated.

The operation is now completed by carrying out one or other of the methods for the *radical* cure of inguinal hernia described above. This applies to patients whose general condition is good. But in the aged and debilitated, in whom any prolongation of the operation involving general anæsthesia and exposure would be serious, it is better to close the wound and postpone until later the radical procedure.

The dressing of such cases cannot be too simple, and in all my own cases consists of sterile gauze without drainage. The gauze is covered with a thick packing of cellulose wadding, secured carefully by broad gauze bandages, which should in all cases include and exercise pressure on the whole scrotum. The pressure on the line of the wound not only prevents oozing of blood or serum into the field of operation, but takes some of the strain off the stitches if a radical cure has been done; and where this has been deferred it is more than ever necessary to prevent the redescent of the hernia through the enlarged and undefended opening. The inclusion of the scrotum within the broad bandage will tend to check any oozing into it, which is especially likely to take place if the sac has been dissected out, or if the veins of the cord have been tied and excised as part of the radical cure (Halsted's operation, see p. 594).

Treatment of suspected bowel. Where the condition of the strangled gut is suspicious, it is hard to give clear indications as to its preservation or resection. In some cases it may be well to draw it well down after free division of the constriction, and, after wrapping it up in gauze dipped in warm sterile normal saline, leave it outside the abdomen for twelve hours or so. If by this time it has not recovered sufficiently to justify its return it must be resected; if then recovered, it can be returned. There are obvious objections to this in the dangers of sepsis and the possible increase of paresis in the bowel. An older practice was to leave the most damaged part of the loop fixed by stitches to the skin wound and to open it for the escape of its contents, postponing any further action until the patient had recovered from the depressing effects of the obstruction and toxæmia, and the bowel from its paresis above the constricted point. But, as I have already said (see p. 610), from my own observation and reading, I cannot help coming to the conclusion that in such cases, where there is well-grounded doubt as to the vitality of the strangled gut, it ought to be at once freely excised. Of course, this demands judgment and skill, but modern surgery is equal to such a demand.

Enterectomy. We may now consider the details of enterectomy for gangrenous bowel, having already considered the principles (see pp. 605–10).

constriction from its superficial to its deeper aspect, whether with scissors or knife, is more in harmony with our general principles of to-day of always seeing what we divide rather than of cutting in the dark. In dissecting from without, the epigastric artery should never be wounded, as it can easily be seen. In any case the division of the compressing structures must be only just enough to release the bowel. Traction by a blunt hook introduced under the constricting tissues will often materially assist in enlarging the opening when partially incised.

While the constriction is being relieved, care should be taken that the gut does *not slip back* into the abdomen. On the contrary, it should be held in aseptic gauze and gently drawn downwards. But it may still be caught by a constriction in the neck of the sac. If this be so, the latter must be divided, and here, too, I prefer scissors or a knife, cutting from without cautiously. When it is clear that the gut is no longer caught above, it is drawn out to a sufficient extent to examine the point upon which the structures have pressed. Inspection of this portion of the bowel *all round* is most important. Its lustre, colour, and circulation may be either normal or at all events but little affected, or it may be discoloured in patches which do not recover their colour when gently pressed upon, and these patches may be coated with lymph. This state of things should be regarded with much suspicion, and the surgeon should have clear views as to the chances of recovery of the tissue before he returns such a loop into the abdomen. I have seen bowel in this condition replaced in the abdomen, and all go well for fourteen days, and then a perforation take place in such a patch. Again, I have seen a loop returned with such patches on the constricted area, and everything remain quite normal, to all appearances, for many weeks, but then symptoms of bad obstruction came on, requiring the abdomen to be opened. The constricted part I then found still narrowed and surrounded by matted coils and firm adhesions, the patient only being saved by resection of three feet of the matted intestine, including the constriction, after which all went well. In other cases the gut is obviously gangrenous, and must not on any account be returned into the abdomen. The treatment in this case will be referred to presently.

But, assuming that the operator has no doubts as to the viability of the intestine, he gently empties it by pressure with the fingers towards the opening and reduces it. The sac is then drawn down and transfixed and tied above the opening in it and cut across below the suture. The portion lying in the scrotum, if much inflamed, can be dissected out; but if healthy it may be left, when it will shrink up. It should not be forgotten that if it is dissected out some time is lost, and a considerable raw surface is left in the scrotum which has much tendency to ooze blood and serum

about to be dealt with (see Fig. 273), in such a way that an equal amount lies on each aspect close side by side. In this position the proximal, *b*, and distal, *c*, parts of the bowel are fixed together between the two blades of a Doyen's clamp, *e*, placed obliquely at a point close to where the two are to be anastomosed. By means of another Doyen's clamp, *f*, the two portions of the folded mesentery, *d*, are brought closely together about 1 inch from the bowel. If the fold be too long to be secured between the blades of one clamp, a second may be used, one of its blades being thrust through the mesentery where the point of the first pair ends.

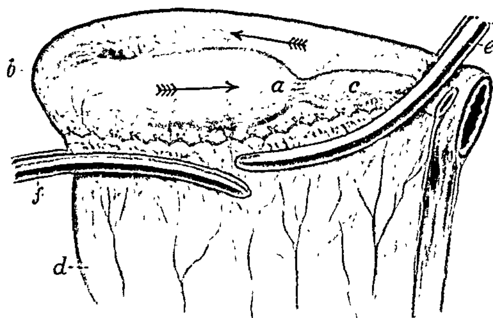


FIG. 273. STEPS OF ENTERECTOMY FOR OBSTRUCTION. Mode of folding the mesentery, *d*, and of suturing its two layers parallel to the intestine; proximal portion at *a*, distal at *c*, with constriction between them. The proximal portion of the tube, *b*, is much larger than the distal, *c*. The clamps holding the bowel and mesentery are shown at *e* and *f*.

The two leaves of the mesentery, *d*, are now rapidly stitched together by threads passed at right angles through both leaves and tied on one side (see Fig. 273). These not only close the opening which would result from the removal of the intestine, but also all the vessels supplying that portion of the mesentery.

When this suturing is complete the wound is carefully repacked all round the intestines with sterile gauze to guard it against infection and the passage of blood-clot into its corners, and another clamp is put on the distal part of the intestine between the constriction and the first pair, *e*, and the bowel is divided across between them. It is then separated from the sutured mesentery all round up to the first clamp,

The damaged loop is first drawn out of the sac and wound under a stream of warm normal saline solution. Only a couple of inches of the bowel distal to the constricted portion need be delivered, but, on the other hand, several feet on the proximal side for reasons given before (see pp. 605–10). This will usually be found, in a case in which the hernia has been badly strangled for any length of time, to be dilated, paralysed, discoloured, and œdematous, and sometimes mottled with flakes of lymph. This distended paralysed portion, loaded with liquid fæces, blood, and mucus, is, as we have seen (see pp. 607–8), as dangerous to the patient as the strangulated loop itself, and for a variable distance incapable of return to a normal condition. How far upwards it is beyond recall and sound enough to hold sutures varies in different cases of course, but the experienced surgeon will be able to form a judgment with the help of eyes and touch. It is usually a question of some feet. It is known from experiment on animals and experience in abdominal surgery, that at least 6 feet of small intestine can be excised without injury to the assimilative processes. At all events within this limit the surgeon can work safely. He should draw the proximal bowel out until he feels and sees that he is dealing with relatively sound intestine, whether it be 2, 4, or 6 feet above the constriction.

The form of anastomosis he will now select will be determined by the amount of enlargement of the proximal gut as contrasted with that below the point of constriction, which will probably be empty and contracted. If the lumen of each be nearly alike, which will be the case if he select a spot high up in the proximal bowel, there is no doubt that an end-to-end junction is the best. Fig. 272 is from a portion of about 6 feet of bowel I removed for gangrene of the intestine from an old woman of seventy-six years of age, making an end-to-end anastomosis which was followed by perfect recovery. But if the lumina differ much in size, so that to neatly adapt their ends would be impossible, the side-to-side junction is the best for the result and easiest for the surgeon. In one case in which I had nearly completed an end-to-end anastomosis at about 6 feet above the constriction, I recognized, when about half through the operation, that the discrepancy between the lumina would prevent a watertight junction, and I had to resect what had been already stitched and make a lateral anastomosis. The patient made an excellent recovery in spite of the additional time spent over the second resection.

Having decided on resection, the first step, as I have formulated the procedure for myself, is to secure all the vessels in the mesentery of the bowel to be removed, and at the same time to close the aperture in the mesentery which will be left when it is cut away. To this end the loop and mesentery are folded on themselves throughout the whole length

about to be dealt with (see Fig. 273), in such a way that an equal amount lies on each aspect close side by side. In this position the proximal, *b*, and distal, *c*, parts of the bowel are fixed together between the two blades of a Doyen's clamp, *e*, placed obliquely at a point close to where the two are to be anastomosed. By means of another Doyen's clamp, *f*, the two portions of the folded mesentery, *d*, are brought closely together about 1 inch from the bowel. If the fold be too long to be secured between the blades of one clamp, a second may be used, one of its blades being thrust through the mesentery where the point of the first pair ends.

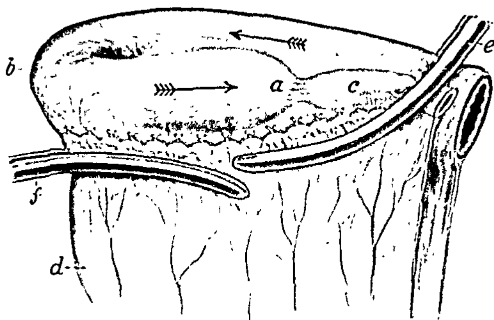


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and is allowed to hang down into a basin of Condy's solution. The third clamp on the divided end is now taken off and the whole loop empties its contents into the basin. And when clamp *e* is removed and only replaced on the distal divided end, the proximal tube, *b*, will drain its higher part still lying within the abdomen aided by pressure on the latter, and much liquid and gas be carried directly away far from the wound into the basin as in Fig. 274.

If when the loaded bowel has thus emptied itself to a certain extent we now find that the lumina of the two portions of bowel do *not* corre-

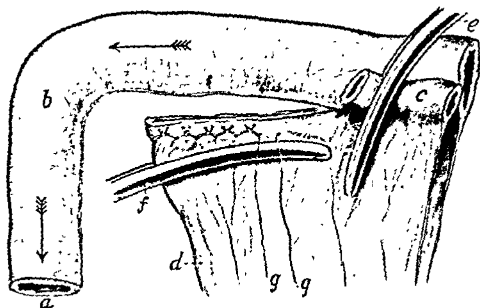


FIG. 274. STEPS OF ENTERECTOMY FOR OBSTRUCTION. The proximal portion, *a*, *b*, has been released when the mesentery, *d*, *g*, has been partially sutured, and is allowed to drain off its contents. The distal portion, *c*, is still clamped by a single clamp, *e*, another, *f*, being left on the mesentery.

spond sufficiently in size to admit of end-to-end anastomosis, a lateral junction may be commenced at once while the bowel continues to empty itself, which it can only do slowly, being in a state of more or less paresis, although the portion hanging over the edge of the table will create to some slight extent a negative pressure within it, in other words a siphon action. We commence then by uniting with an ordinary sewing-needle, threaded with a long silk or linen thread, the two tubes laid side by side above the clamp *e*. This thread, which includes only the serous and muscular coats, is first tied but left uncut, and the two tubes are sewn together for about 2½ inches in one straight line with the same needle and thread, forming a continuous suture (see Fig. 275). The moment has now come

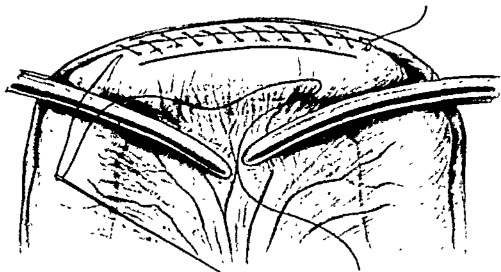


FIG. 275. COMMENCEMENT OF LATERAL ANASTOMOSIS. The two portions of bowel are held side by side and a sero-muscular suture is made first, leaving a 'tail thread' at one end. Then the bowel is opened along the lines indicated (black).

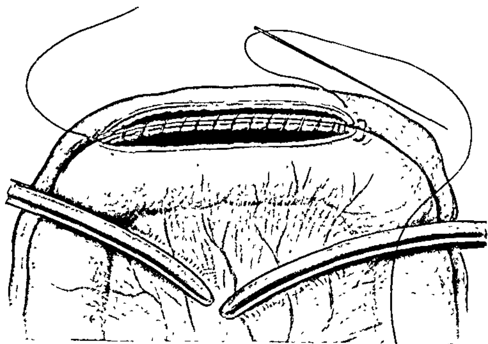


FIG. 276. TWO LOOPS OF SMALL INTESTINE HELD TOGETHER FOR LATERAL ANASTOMOSIS BY TWO DOYEN'S CLAMPS. The two adjacent edges of the opening are united by a single continuous suture passing through all the coats. The thread is shown turning the corner on its way back to be finished off by being knotted with the 'tail thread', where it began on the left of the figure. When this has been completed the suture is reinforced by a continuous sero-muscular suture going all round outside the first line. This sero-muscular suture has been made on one side previous to opening the gut.

for opening the two portions of gut, and this must be done with great care, so as not to soil the line of suture just made. The needle and thread employed for this first sero-muscular suture should be well covered with a sterile fabric until they come to be used again to complete the circle of suture.

To this end the portions of the intestines sewn together, as above, are emptied by pressure, and a clamp is made to include them both side by side at about 1 inch distant from either end of the line of suture. These will prevent the bowel from filling again. The two tubes are opened

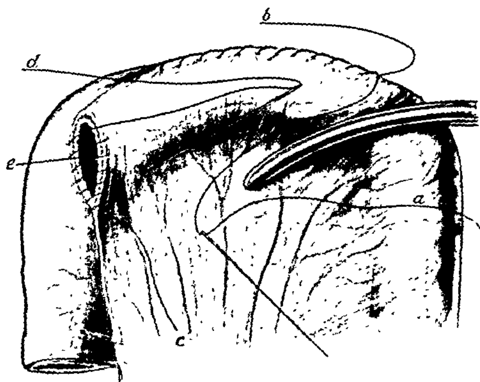


Fig. 277. Enterectomy for Obstruction. To show the completion of the sero-muscular side-to-side suture and the final tie of needle thread and 'tail thread', *a* and *b*. Also the closure of one of the ends, *e*, by the thread *c*, *d*, which passes through all the coats. This is followed by a sero-muscular suture over the inverted end.

parallel to the line of suture, and at about ⅛ inch from it, and for about 2 inches. This is best done with a pair of scissors, one point of which is thrust through the coats about ¼ inch short of the line of suture, and an even straight cut made with it to within ¼ inch of the other end of the previous line of suture. *Both openings should be exactly of the same length.* When they have been carefully wiped clean with dry sterile gauze, their adjacent edges are united with a fresh needle and thread, which this time takes up *all* the coats with a continuous suture carried from end to end of the openings (see Fig. 276). Here the same suture is

carried round the openings, and brings the opposite edges of them into contact until it arrives back at the point from which it started, and is tied to the 'tail thread', left long for the purpose. This continuous suture, which brings the cut edges of the openings into firm contact, taking up all their coats, will, as a rule, stop all bleeding. It must be carried out as cleanly as possible, the edges being frequently wiped with dry gauze during and after its completion.

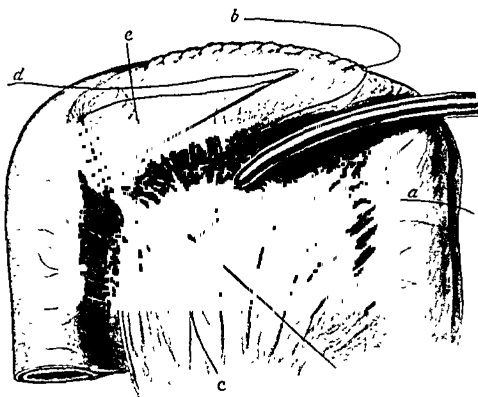


FIG. 278. ENTERECTOMY FOR OBSTRUCTION. Showing the completion of the closure of one of the divided ends (distal) by the sero-muscular suture *c*, *d*, the first 'all coat' suture, *e*, having been pushed into the lumen.

The first needle and thread, left uncut for the purpose, are now uncovered, washed with spirit, and employed to continue the sero-muscular suture round the junction of the openings (see Fig. 277), at the same distance from them as was the first line of all. When it has encircled the sutured openings, it is tied to its own 'tail thread' and cut off, the anastomosis being now finished, and the clamps are removed.

But the ends of the anastomosed bowels have still to be closed, one of which has not yet been cut across at the level of the other. The end of the distal portion is first closed by a needle and thread, passed through all its coats in continuous suture (see Fig. 277). This portion is then pushed into the lumen of the gut for about ½ inch, and

the sero-muscular coats are closed over it securely by continuous suture (see Fig. 278). All this time the proximal tube, hanging over the edge of the table into the basin, has allowed gas and liquid to flow off from the intestinal canal intermittently, often in large amount. But the anastomosis having been made, it is now clamped and cut across at the same point at which the distal was divided, and is closed in the same manner as in Figs. 277, 278.

A careful revision of the whole wound now follows, all clots being wiped away with gauze dipped in sterile normal saline solution. The packing with gauze is then removed, and the inguinal or ventral wound is closed in the usual way after a final revision. The question of leaving a drain in one corner must be decided by the individual surgeon, but personally I prefer to dispense with any drain, except under very special circumstances. If, for instance, the sac, on being opened, were found in a state of foul suppuration, and more or less sloughy, it would of course be taken away, and its neck, being secured near the situation of the external ring, would be packed with gauze, not only as a means of drainage, but also to prevent any coil of gut from being protruded as the result of vomiting or coughing. This gauze would be left in for at least forty-eight hours, and if, on removal, the wound were clean, would not require to be replaced. In this case the neck of the sac could be drawn down, transfixed, and tied off, and under certain circumstances the rings could be stitched up by one or other of the methods for radical cure mentioned above. But in other cases the sac, although inflamed, can be removed cleanly, and its neck sutured in healthy tissue above, after which the radical closure of the rings is, in my opinion, sound practice. I took this course in the first case in which I successfully removed a long loop of 36 inches of intestine for gangrenous inguinal hernia, and did not regret it. The radical cure followed immediately on the reduction of the anastomosed ends.

The danger of leaving the sac and rings unsutured, even though packed and firmly bandaged, is no imaginary one. I have seen a case which showed perfect union of the anastomosed ends of a resected intestine die of obstruction several days later, due to the forcing out of a fresh coil of bowel into an unclosed ring during chloroform vomiting, in spite of firm packing. The condition was only recognized too late to be remedied

When it is decided to attempt an end-to-end junction of the bowel after resection, the suture of the mesentery and detachment from it of the distended bowel is carried out as just described (see p. 617). The proximal portion of the bowel is unloaded into the basin, aided by pressure on the abdomen. Supposing its lumen to be now *nearly* the same as that of the divided proximal end, the two are laid side by side and are grasped

between the blades of a Doyen's forceps (see Fig. 271). But, though grasped together side by side at one point, they must be previously adjusted so that the central axes of both portions of the bowel will cross at a very considerable angle at the spot at which they are to be divided and sutured. The axis of the proximal portion should be nearly at a right angle with the forceps blades, the axis of the distal should form a very small angle with them (see Fig. 279). When they are cut across distally to and parallel with the blades, the opening of the tube leaving the abdomen

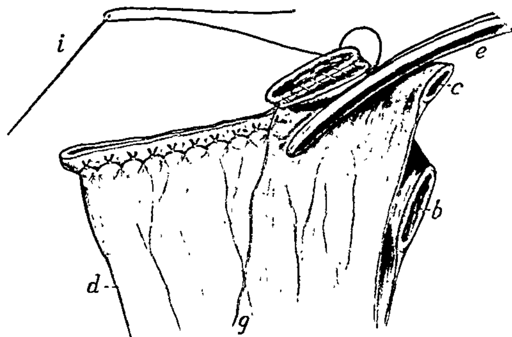


FIG. 279. STEPS OF ENTERECTOMY FOR OBSTRUCTION. Mode of including both proximal, *b*, and distal, *c*, portions at different angles in one clamp, *e*, before they are divided preliminary to 'end-to-end' suture. The proximal is cut nearly transversely; the distal very obliquely, so as to give it a larger lumen, more equal to that of the proximal portion. The needle and thread, *i*, bring the adjacent sides of both portions together by passing through all coats. The corner of the free margin of both tubes is about to be turned. *d* and *g*, the mesentery, has been already sutured. The threads are thicker in the drawing than they should be.

will be slightly oblique to its axis, while that of the bowel entering the abdomen will be very oblique to its axis, and consequently much larger than if cut across like the other. This will render the two lumina to be stitched approximately the same, and they can be sutured together without any folding. This oblique division of the bowel has the further advantage that all the edges receive a full blood-supply in all their coats from the mesenteric margin. Were they cut across obliquely in the opposite sense, so that the free margin of the tube was longer than the attached,

there would be a bad blood-supply to the free margin, assuming that the vessels took a fairly straight course transverse to the axis of the bowel, as is the case. This probably explains the leakage which was observed to take place near the free margin of the bowel in earlier enterectomies, before it was recognized that it was wrong to divide the intestine at right angles to its axis. It is now the rule to cut away more from the free margin of the tube than from its mesenteric side, as above described.

The suturing of the two lumina begins at the mesenteric margin of each. The same round sewing-needle and thread is used as in the former case. With this the two cut edges of the mesentery are first united through all their serous coats close to where these diverge to encircle the two portions of the intestine. In knotting this a long 'tail thread' (at *g*) is left uncut. The needle is now passed from the lumen through all the coats of one of the adjacent sides of the cut intestines, from the mucous surface of one to the mucous coat of the other at the mesenteric margin of each. Then it is made to pierce all the adjacent coats of both again at about $\frac{1}{4}$ inch further up, and so on until the non-mesenteric margins of the lumina are reached by this continuous suture. Here the corner is turned as the opposite edges are reached, but always the needle transfixes the edges, taking in all the coats of each, from mucous to serous and from serous to mucous, each time, until the suturing has come round again to the starting-point, and the running suture, which should end on the serous coat, is tied with the first 'tail thread', and both are cut off. A second clamp is now made to enclose the two tubes a few inches higher up, and that close to the sutured end is taken off. This will enable the surgeon to evert the already united ends far enough to introduce a continuous sero-muscular suture all round the bowel over the first, commencing and ending as before. Special care must be taken to secure accuracy of adjustment of the stitches at the mesenteric margins and the covering of the first row of suture by the second.

The whole area of operation is now wiped clean, and then finally mopped over with gauze dipped in sterile normal saline solution, after which all the preliminary gauze packing is carefully removed, and the gut is placed gently within the abdomen in such a way as to lie straight exactly under the abdominal wound. The question here of drainage is the same as in the case above. Wherever it can be avoided it should be dispensed with. One reason for avoiding the gauze drain or tube is that as reparative lymph is thrown out around the sutured portion, it is better for the prospects of union without leakage that this lymph should immediately glue the part to other serous surfaces than to the gauze, which, on its removal, would tend to bring away with it the very material upon which we depend for the repair of the lesion. If no drain be put

in, the plastic lymph solders the sutured part within a few hours against other coils or the serous parietes, at all events *pro tem.* Subsequently, there is plenty of evidence to show that the surplus lymph is absorbed and the gut is freed again. A rubber tube in any case is undesirable, as its pressure on intestine has been known over and over again to produce pressure, inflammation, and perforation. Obviously, the leading thought throughout the whole procedure is to keep everything aseptic. If this be done from beginning to end the abdominal wound can be closed at once without drainage.

CHAPTER XXI

OPERATIONS FOR STRANGULATED FEMORAL, UMBILICAL VENTRAL, DIAPHRAGMATIC, AND OBTURATOR HERNIA

FEMORAL HERNIA

For this condition, usually done on females in mature or advanced life, the procedure may be of the simplest kind, provided the gut to be released is sufficiently sound to be viable. Such a state of things will be considered first.

Operation. The incision should commence about 1 inch above Poupart's ligament, and run vertically downwards over the tumour for 3 inches. It should be made with caution, as the structures between the skin and contents are often very thin, and the sac, or even bowel, might be wounded by a bold stroke of the knife. For this reason some surgeons prefer to pinch up a fold of skin over the tumour below and parallel to Poupart's ligament, and transfix it, making the incision by cutting from within outwards. Personally I prefer the direct cut, with due care.

The lips of the incision being held apart with hooks, the sac can usually be rapidly exposed by dissection with a pair of forceps held in each hand, or with a steel elevator and forceps separating the *loose tissues which cover it. When of moderate size, it is well* to completely enucleate the sac at once and turn it out of the wound, stuffing the latter with sterile gauze. The sac is then opened with great caution lest the bowel within, which is usually under great tension, should be wounded. When the sac is once opened the aperture is best enlarged, in my opinion, by means of scissors. Any fluid contained in it is then wiped away with sterile gauze, and the contents are carefully washed with a stream of warm normal saline and again mopped as before. A most important point is now reached, and we have to determine, before going further, whether the strangled loop can safely be returned into the abdomen or is too damaged to admit of this. The point can only be settled by a very careful examination *of the part immediately pressed upon by the constriction*, whether this lie in the sac or outside it. To examine it thoroughly the loop must *in every case* be drawn down until the nipped portion and a considerable length

of the proximal gut can be well seen and felt. This is sometimes possible without dividing the constriction. But it is better, unless this is quite easy, to first divide Gimbernat's ligament upwards and a little inwards by passing under it a probe-pointed knife outside the sac. If the bowel cannot now be drawn down, the knife can be passed into the sac along the finger which guards the bowel, and a cut made in the same direction. Another way which I often practise is in many cases to be preferred, involving as it does less risk of wounding an irregular obturator artery. This is to enlarge the opening in the sac with blunt-pointed scissors upwards until the neck is freely divided. There is nothing now to prevent the drawing out of the loop, unless fresh adhesions be present. In this case great caution is necessary, as these adhesions indicate that the bowel is damaged, and they may be the only barrier to the escape of fæces from an underlying perforation, or cover a part ready to perforate under strain. When there is any suspicion, based upon the presence of lymph round the neck of the sac or discoloured patches, that the constricted part is unsound and likely to give way, the packing in and around the wound should be very carefully overlooked, so that if in drawing down the bowel it should commence to leak, the contents shall not soil the parts around. Then the bowel is drawn cautiously into the wound, and if intact, or at least viable, is replaced by gentle pressure. After this the sac is tied off, and a radical cure, on the lines described on page 604, is done.

But it must be admitted that it is not an easy matter to determine by the eye, by touch, or any other means, the exact amount of morbid change within a loop of bowel which has been strangulated. The alterations in colour and texture which are seen have been described already (see p. 608 *et seq.*), and explained up to a certain point. But only experience of these cases gives anything like confidence in judgment on the point. Some strangled loops are obviously in a state of gangrene; others are less so, and still ought not to be put back; and others are doubtful. But I have long contended for and acted on the principle that, whenever any *serious* doubt exists in the mind of the surgeon as to whether a loop is viable, *i. e.* capable of recovery, it should not be put back. From a long and large experience in this field, I feel sure that the dangers of returning doubtfully sound gut into the abdomen, either to perforate there, or, without doing so, to set up peritonitis—either fatal or productive of dangerous adhesions—or to undergo contraction as the result of ulceration of its mucous membrane, are greater than to deal with the damaged part by removal.

It remains to discuss what the other alternatives to replacing a strangled loop of gut are.

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Operation. The incision should commence about 1 inch above Poupart's ligament, and run vertically downwards over the tumour for 3 inches. It should be made with caution, as the structures between the skin and contents are often very thin, and the sac, or even bowel, might be wounded by a bold stroke of the knife. For this reason some surgeons prefer to pinch up a fold of skin over the tumour below and parallel to Poupart's ligament, and transfix it, making the incision by cutting from within outwards. Personally I prefer the direct cut, with due care.

The lips of the incision being held apart with hooks, the sac can usually be rapidly exposed by dissection with a pair of forceps held in each hand, or with a steel elevator and forceps separating the loose tissues which cover it. When of moderate size, it is well to completely enucleate the sac at once and turn it out of the wound, stuffing the latter with sterile gauze. The sac is then opened with great caution lest the bowel within, which is usually under great tension, should be wounded. When the sac is once opened the aperture is best enlarged, in my opinion, by means of scissors. Any fluid contained in it is then wiped away with sterile gauze, and the contents are carefully washed with a stream of warm normal saline and again mopped as before. A most important point is now reached, and we have to determine, before going further, whether the strangled loop can safely be returned into the abdomen or is too damaged to admit of this. The point can only be settled by a very careful examination *of the part immediately pressed upon by the constriction*, whether this lie in the sac or outside it. To examine it thoroughly the loop must *in every case* be drawn down until the nipped portion and a considerable length

of the proximal gut can be well seen and felt. This is sometimes possible without dividing the constriction. But it is better, unless this is quite easy, to first divide Gimbernat's ligament upwards and a little inwards by passing under it a probe-pointed knife outside the sac. If the bowel cannot now be drawn down, the knife can be passed into the sac along the finger which guards the bowel, and a cut made in the same direction. Another way which I often practise is in many cases to be preferred, involving as it does less risk of wounding an irregular obturator artery. This is to enlarge the opening in the sac with blunt-pointed scissors upwards until the neck is freely divided. There is nothing now to prevent the drawing out of the loop, unless fresh adhesions be present. In this case great caution is necessary, as these adhesions indicate that the bowel is damaged, and they may be the only barrier to the escape of fæces from an underlying perforation, or cover a part ready to perforate under strain. When there is any suspicion, based upon the presence of lymph round the neck of the sac or discoloured patches, that the constricted part is unsound and likely to give way, the packing in and around the wound should be very carefully overlooked, so that if in drawing down the bowel it should commence to leak, the contents shall not soil the parts around. Then the bowel is drawn cautiously into the wound, and if intact, or at least viable, is replaced by gentle pressure. After this the sac is tied off, and a radical cure, on the lines described on page 604, is done.

But it must be admitted that it is not an easy matter to determine by the eye, by touch, or any other means, the exact amount of morbid change within a loop of bowel which has been strangulated. The alterations in colour and texture which are seen have been described already (see p. 608 *et seq.*), and explained up to a certain point. But only experience of these cases gives anything like confidence in judgment on the point. Some strangled loops are obviously in a state of gangrene; others are less so, and still ought not to be put back; and others are doubtful. But I have long contended for and acted on the principle that, whenever any *serious* doubt exists in the mind of the surgeon as to whether a loop is viable, *i. e.* capable of recovery, it should not be put back. From a long and large experience in this field, I feel sure that the dangers of returning doubtfully sound gut into the abdomen, either to perforate there, or, without doing so, to set up peritonitis—either fatal or productive of dangerous adhesions—or to undergo contraction as the result of ulceration of its mucous membrane, are greater than to deal with the damaged part by removal.

It remains to discuss what the other alternatives to replacing a strangled loop of gut are.

The older practice, in cases of hopeless gangrene or very doubtfully sound loops, was to leave their relations to the neck of the sac undisturbed after fixing them in the wound, and to open them freely. By these means an artificial anus was formed, by which the obstruction was more or less relieved, and the bowel above gradually emptied itself of its putrid contents. This seemed to the surgeons of a generation ago to offer the best hopes for immediate recovery, the further treatment of the case being deferred until the pent-up fæces and other foul matters had been discharged, and the serious general condition had been recovered from. But an examination of the records of any large hospital (*Lancet*, May 30 and June 6, 1903) will show that these hopes were slender—the mortality in such cases was very high.

The only other alternative is to remove the whole unsound loop, and to make a junction between the proximal and distal part of the intestinal tube. My own experience and reading lead me to the conclusion that this immediate resection of the damaged portion of the bowel is, in skilled hands, the soundest course both in theory and practice. But one golden rule must be followed in all cases of serious strangulation, if resection is to be safe. This is to excise, together with the gangrenous loop, at least some feet of the bowel above it; in other words, all the proximal bowel damaged by the retention of fermenting fæces and toxins, which is incapable of return to the normal state (see p. 606 *et seq.*). The intrinsic difficulty of such a procedure, where several feet of gut are removed, is no greater than when only a few inches are taken away, and the strain on the patient's strength is not greater. Without such an extensive removal most of these cases will die, as we know from experience and might expect theoretically. And if such cases be carefully examined after death, it will be seen that the stitches passed through the tissues of the proximal end have cut through the damaged coats, while those in the distal end are holding. Another cause of death in such cases is the migration, through the devitalized tissues of the proximal end, of bacteria, which set up peritonitis. And there is yet a contributory cause in the presence of large quantities of putrid matters with their toxins in the proximal intestine, which, being in a state of paresis or complete paralysis, has little or no power of evacuating itself into the contracted distal portion. From this stagnant fluid poison is being absorbed into the system, and soaks the damaged intestine itself, preventing its recovery even after a watertight junction has been made, following on the resection of the *actually gangrenous* strangulated loop, if this alone has been removed

The amount to be removed will vary in length, usually more or less in proportion to the time the gut has been strangulated, but is also influenced by several other factors. The rule should be that the proximal

part of the gut should be drawn out of the wound for several feet until its texture is seen and felt to be nearly or quite normal, and at such a spot only should the anastomosis be made, all the damaged portion being removed.

But the resection of such a length of intestine, and the return of the sutured portion with its voluminous mesentery without violence, is a difficult matter through so small an opening as the femoral ring, unless Poupart's ligament is freely divided, and this is much to be deprecated. It is far better in a case where a considerable length of intestine has to be removed, with and above a strangled loop, to open the abdomen at once in the middle line, and make the anastomosis between healthy distal and proximal portion of intestine. The portion to be removed, with its divided ends closed, cleaned, and protected with sterile gauze, can then be drawn and excised out through the femoral ring with far less danger of infection than if the strangulated coil were first drawn into the peritoneum, no matter however well packed with gauze. Or the loop may be first drawn down until the constriction is clear of the ring, and both limbs having been tied with a strong silk or linen thread, all that is gangrenous and damaged can be cut away below the threads, and after the abdomen has been opened in the middle line, the stumps of both ends, covered with gauze, can be drawn into the abdomen and out of the ventral wound, and then the anastomosis at any height can be completed (see Figs. 275–8). Both methods have given me good results. Fig. 246 is from a specimen which I removed after opening the abdomen, as it was too voluminous to deal with, in its semi-gangrenous, œdematous state, through the femoral opening. It will be seen that it consists of the last foot or so of the ileum, the cæcum, and part of the ascending colon which could not be reduced. When sound bowel had been reached above, after opening the abdomen, the ileum was planted into the ascending colon, and all the gut below the anastomosis was pulled out of the femoral opening. The patient made an excellent recovery.

To save space, the details of removal of such a portion of gut are given and illustrated on pp. 616–23, in considering the treatment of resection of gangrenous inguinal herniæ. The procedure is naturally the same whatever the form of constriction be which causes the gangrene.

UMBILICAL AND VENTRAL HERNIA

The same general rules apply to operations for the relief of strangulated umbilical and ventral hernia as to those for the radical cure of the non-strangulated variety (see p. 572). The treatment of the skin, the sac, and the constriction are the same in both instances. But, inasmuch as

these hernial protrusions frequently involve the colon, the question of what to do when the latter is gangrenous, or nearly so, has to be differently answered. Here we are sure to have a quantity of fæces pent up above the constriction in a part of the gut which cannot be at once extensively removed for anatomical reasons. In such cases, then, it will be necessary, if the colon be gangrenous, to secure the healthy bowel above in the upper part of our incision, and then either simply open the damaged loop or sweep it away at once. The artificial anus thus formed, after it has unloaded the intestines, can be closed by a subsequent operation in many cases. But in ventral herniæ the small intestine will often be involved to a large extent, and, if gangrenous, can and should be at once excised widely for reasons already given (see pp. 606 *et seq.*). The methods for doing this enterectomy have been already described (see p. 615). It has fallen to my lot to have to deal with some such cases where large tracts of small intestine have been found in a gangrenous condition in ventral herniæ. One case already published may be alluded to here. It was that of an old woman of 76, with a huge ventral hernia of many years' standing, following an ovariotomy. This had become recently strangulated and was putrid for many feet when the sac was opened. I immediately resected 5½ feet and made an end-to-end anastomosis, closing the abdominal wound without drainage. The patient made a most perfect recovery, the wound healing without a flaw, and I saw her two years later in excellent health. No artificial anus with drainage of the gut would have saved this patient. The boldest measure proved to be the safest. I could add other analogous cases if space permitted. If in these cases it had happened that the colon had been gangrenous, it would have had to be treated as described above in cases of umbilical hernia.

DIAPHRAGMATIC HERNIA

If diagnosed, this hernia would be treated as an internal strangulation, and what has been said above as to the ways of dealing with the gut would apply here. No special rules can be laid down as to the incision in the abdominal wall or the management of the case, beyond those given for other herniæ.

OBTURATOR HERNIA

This condition has recently been shown to be more frequent than is commonly supposed, and, in any obscure case of intestinal obstruction in those in middle life, must be taken into consideration. It is very rarely diagnosed until the abdomen is opened on account of the obstruction.

After this its recognition is not difficult. A finger passed to the obturator opening will immediately find the anchored bowel with its distended proximal and empty distal arm. The loop involved, which is usually very small, can, as a rule, be disengaged from within, aided by pressure from without over the pectineus muscle. But, in view of the fact that it may be softened or actually gangrenous, no attempt to draw it into the abdomen should be made until gauze has been well packed round it and both afferent and distal arms have been lightly clamped. If this be not done the peritoneum may be soiled by the damaged bowel, or by its giving way with extravasation of fæces. But with these precautions gentle traction may be made on the included portion until it is released. If too much damaged to be viable, the damaged loop must be excised on the lines given above.

If possible, a radical cure should follow. This may be done by inserting a toothed forceps into the sac, seizing its fundus, and inverting it into the abdomen, where it is tied at its neck and cut away. Should this not be feasible, a vertical incision is made over the pectineus muscle, its fibres separated, and the sac exposed. When it has been dissected free, it can be pushed into the abdomen, inverted, and tied off. An interesting case where this was done has recently been described by Messrs. Corner and Huggens (*Trans. Roy. Soc. Med.*, Sect. of Surg., February, 1909).

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SECTION IV

OPERATIONS UPON THE STOMACH AND INTESTINES

PART IV

OPERATIONS UPON THE RECTUM AND ANUS

BY

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CHAPTER XXII

METHODS OF EXAMINATION OF THE RECTUM AND ANUS

Inspection. For the examination of male patients, the knee-elbow position, with the thighs vertical, is the most generally useful; female patients may be in the left lateral semi-prone position, the buttocks slightly over the edge of the couch, the hips and knees well flexed, the upper thigh crossed over the lower, the under arm brought out behind the patient's back, and the face turned towards the couch.

The buttocks should be drawn gently apart and the anus and surrounding region inspected. If there be discharge present it should be wiped away and its source noted. The radiating folds of skin should be examined for any orifice, crack, or excoriation. It will be noted if the skin be supple and normal in appearance, or if it has an opaque look, as in cases of chronic pruritus ani. The orifice of a fistula, any external piles, tags of skin, ulceration, mucous patch, papilloma, or eruption of any kind will be at once seen. The condition of the sphincter will be noticed, whether it is tightly contracted, as when anal fissure is present, or obviously relaxed, as in some cases of carcinoma of the rectum, in nerve lesions such as tabes dorsalis, or in elderly people, also in old cases of prolapse of one or more coats of the bowel, or of internal piles. It should be noted that the sphincter is normally more powerful in males than in females. If internal piles be suspected they may often be made to protrude by everting the anal margin with the fingers, while making the patient strain down. Pressure on the peri-anal region by the finger will reveal any induration due to an abscess, or the track of a fistula, or perhaps a boggy sensation due to a cavity containing tuberculous debris.

Digital examination. The external examination being completed, the index-finger, lubricated with vaseline, should be gently inserted into the bowel, the patient being at the same time directed to strain down, if necessary, to relax the sphincter. If a fissure be present, considerable pain is often caused and the finger is tightly gripped by the sphincter, although usually the pain can be modified by pressing well forwards, as a fissure is generally situated posteriorly. The finger carefully swept

proctoscopes are made of various lengths, but for this purpose they have mostly given place to the pneumatic sigmoidoscope. The bivalve speculum (see Fig. 282) is useful when douching the rectum or making



FIG. 280. MUMMERY'S ANAL SPECULUM.

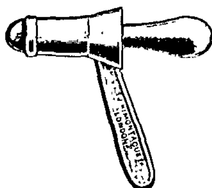


FIG. 281. KELLY'S SHORTEST PROCTOSCOPE.

applications to its lower part and sometimes for purposes of examination. In introducing these instruments, they should be passed straight in for the first $1\frac{1}{2}$ inches and then directed backwards towards the hollow of the sacrum, because the axis of the anal canal is almost at right angles to that of the rectum.

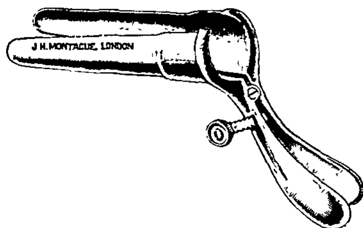


FIG. 282. DILATING ANAL SPECULUM.

The sigmoidoscope. This instrument is of the greatest use for the inspection of the rectum and sigmoid colon ; a better view is obtained than with the proctoscope and its introduction is easier and safer. Strauss's sigmoidoscope consists of a metal tube (see Fig. 283) 14 inches or 35 centimetres in length and equal in diameter to a No. 8 rectal bougie, *i.e.* 2 centimetres. The tube is marked externally in inches or centimetres, and is fitted with an obturator to facilitate its introduction, also with a detachable handle. On removal of the obturator, a small electric lamp, carried on a long rod, is inserted and passed close to the distal extremity of the tube. The rod is attached to a metal collar which is fixed into the proximal end of the tube by a bayonet-joint. Through the collar the wires from the lamp are conducted to a couple of terminals. The collar is closed at its proximal end by a glass window in a metal rim, which fits into the collar by a bayonet-joint. A small hand-bellows is connected by a stop-cock to the proximal end of the

round inside the bowel will detect the presence of foreign bodies or fæcal material, whether the bowel is ' ballooned ', as in some cases of carcinoma of the rectum, also if the mucous membrane has its normal velvety feeling. There may be slightly depressed areas where this is lost, indicating the presence of ulceration; the edge of an ulcer, perhaps thickened, may be felt, and the mucous membrane may not glide as freely as it should over the muscular coat of the bowel. A small depression, usually within an inch of the anus and between the two sphincters, may be the internal orifice of a fistula; if situated higher up, it may be at the apex of a small projection and its track may be felt as an elongated induration outside the mucous membrane.

A bi-digital examination is often useful, the index-finger being within the bowel, the thumb of the same hand applied to the parts around the anus ; gentle pressure by the thumb and finger on the parts between them will at once lead to the detection of any induration or the reverse, also to any abnormality of the coccyx. Sometimes the squatting position with the patient straining down may be necessary to bring a tumour within reach ; or the lithotomy position with the patient under a general anæsthetic, to enable the surgeon to make a bi-manual examination to *decide if a growth be movable or not. It is most important to examine* every part of the mucous membrane within reach ; care must be taken to pass the finger well back into the hollow of the sacrum, or it may pass up in front of a growth situated in the posterior wall of the bowel and lead to its being overlooked. The finger passed up the bowel may find its lumen gradually becoming narrower, due to the presence of a fibrous stricture. Tumours outside the bowel will be felt, perhaps, pressing on to and partly occluding its lumen ; the mucous membrane will be smooth, velvety, and movable over the tumour. A common *error is to mistake the uterus for a tumour. In some cases it will be* advisable to give a simple enema and when it has acted to at once inspect the anus, when a prolapse of mucous membrane, internal piles or a polypus, not otherwise visible, may be brought into view.

Specula. For inspection of the anal canal, Mummery's anal speculum is a very convenient form (see Fig. 280). For the inspection of the whole circumference of the anal canal and the parts immediately above, Kelly's shortest proctoscope is the most convenient instrument (see Fig. 281). It is 2¼ inches in length and equal in diameter to a No. 10 rectal bougie. The author's modification, which consists of a rim of metal round the distal extremity, makes the instrument much less likely to damage the mucous membrane when the obturator is removed. As originally made, the end of the instrument was too sharp and liable to cause abrasions. For inspection of the bowel higher up, Kelly's

under the guidance of the eye, is passed upwards and backwards towards the sacral concavity. The proximal end of the tube is now raised, to allow its distal end to pass over the pelvic brim. When this has been accomplished, its onward progress is generally easy. If during an examination the view is obstructed by a small amount of fluid or liquid fæces, if Strauss's instrument is being used, the lamp should be removed, and the proximal end of the tube directed downwards; the fluid will at once run out through it. Or the fluid may be removed by pledgets of cotton-wool on an applicator or held in long crocodile forceps; the lamp and window are then readjusted and the examination continued.

Soon after the introduction of the instrument the lowest valve of Houston may cause some little difficulty in its onward passage. This is soon overcome by frequently altering the axis of the tube, and as the pressure of the air distends the bowel and draws the mucous folds out of the way, the lumen becomes apparent and the instrument is passed higher and higher. When it has reached about the level of the second sacral vertebra, the rectum often appears to end in a blind pouch. When this happens it is necessary to withdraw the sigmoidoscope a little and direct its extremity to one or the other side in order to enter the sigmoid loop, which in these cases appears to join the rectum at an angle, and its entrance may be more or less hidden by a fold of mucous membrane. In the majority of cases, when this difficulty arises, the entrance will be found on the right side.

Difficulties may be met with owing to the bowel not having been properly cleared out, to hypersensitiveness on the part of the patient, to the presence of tumours or strictures within the bowel, or tumours or adhesions or inflammatory extravasations outside the bowel, partly occluding it by pressure.

tube. The handle and stop-cock prevent the instrument from being introduced more than 12 inches or 30 centimetres, but this is sufficient to examine the entire rectum and the greater part of the sigmoid colon. In Tuttle's sigmoidoscope, the rod carrying the lamp has a separate tube, lying outside the visual tube and terminating in a small crystal glass bulb for the lodgment of the lamp. This somewhat increases the circumference of the instrument, but the lamp is protected from fouling by fæces or discharge, and it does not interfere in any way with the visual area.

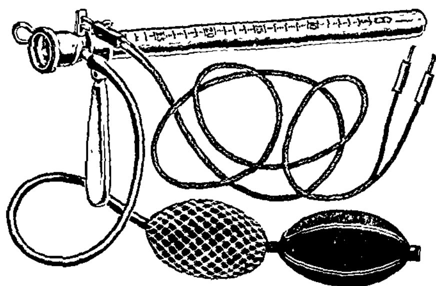


FIG. 283. STRAUSS'S SIGMOIDOSCOPE.

Mode of use. For a successful examination with the sigmoidoscope, the bowel must be well emptied, if necessary by an aperient given at least twenty-four hours previously and one or more enemata on the morning of examination.

The patient is placed on a high couch or table, and all tight garments over the abdomen are loosened or removed. The genu-pectoral position is the best for both sexes when no anæsthetic is used, but for an examination under anæsthesia the left semi-prone position, with a good hard cushion under the pelvis, is the best. Anæsthesia is not required except in very sensitive subjects. The tube, warmed and lubricated with vaseline, is inserted while the patient relaxes the parts by straining down, and the obturator is removed as soon as the tube has reached the rectal ampulla, *i.e.* the dilated portion of the rectum immediately above the anal canal. The collar, closed by the glass window and carrying the rod and lamp, is now attached to the tube, and the light is switched on. Air is pumped in by means of the bellows, and the instrument,

edges of the incisions are also undercut for about one-third of an inch. The flaps are raised as far as the anus, exposing the fibres of the external sphincter, and the dissection should be continued up to beyond the muco-cutaneous junction. All bleeding being completely arrested, the flaps are replaced and sutured in position by interrupted silkworm-gut sutures, and the wound is dressed with gauze and collodion. A rubber tube should be inserted into the rectum in order to convey flatus away from the operation area.

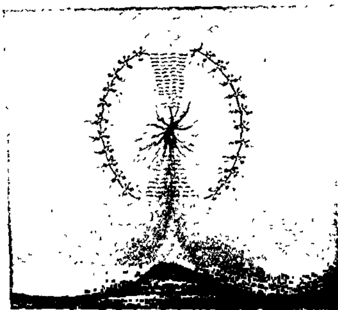


FIG. 284. BALL'S OPERATION FOR PRURITUS ANI. The flaps, which have been turned inwards as far as the mucous membrane of the anal canal, have been replaced and sutured. The fine transverse lines indicate undercutting of the bridge of skin between the flaps. The undercutting beyond the concave edges of the incisions is not indicated.

After-treatment. The patient should be kept recumbent for ten days; the bowels should be opened on the fourth day after operation. If the patient remains comfortable the wound should be inspected after the bowels have acted, and will usually be found to have healed by first intention. The part should be cleansed and irrigated with an antiseptic solution two or three times daily and a dry boric lint or cyanide gauze dressing kept applied. The stitches, if not causing irritation, should be removed at the end of a week.

Complications. Provided the wound be kept aseptic these are absent. If the wound becomes infected the stitches will have to be removed, as a suppurating wound will be present and there will be risk of the formation of an inguinal bubo. Healing will be delayed, but will take

CHAPTER XXIII

OPERATIONS UPON THE ANUS

FOR PRURITUS ANI

Cauterization. *Indications.* Where in long-standing cases medical treatment has failed to give relief.

Operation. The patient having been anæsthetized, the anus is forcibly dilated. If any tags or radiating folds of skin are present they should be snipped off with scissors. The flat side of a Paquelin's cautery point at a white heat is then lightly applied to the whole of the affected anal skin. If every part of the diseased area be carefully stroked twice with the cautery at this temperature, neither too much nor too little burning will be produced, the epithelium only will be partially destroyed and ulceration will not be caused. The applications should start just inside the anus and extend radially.

After-treatment. The patient should be kept recumbent for a few days and an antiseptic ointment, such as eucalyptus, kept constantly applied. The parts should be irrigated twice daily with an antiseptic lotion. The bowels should be opened in two or three days' time by the administration of an aperient.

Results. Some cases are cured; in others the relief is only partial, but in these local applications which previously had failed will now *have the desired effect; whilst in a small percentage the operation fails.*

Ball's operation. *Indications.* This operation is indicated in intractable cases due to some change in the sensory nerves of the affected area. Its object is the division of all the terminal branches of the affected nerves.

Operation. The part having been shaved and prepared in the usual way, the patient is placed in the lithotomy position and a semicircular flap of skin and subcutaneous tissue is dissected up from without inwards towards the anus, raising the whole of the affected area on one side. This is repeated on the opposite side, taking care to leave a bridge of skin both in front and behind about an inch wide. These bridges, both in front and behind, are undercut to well beyond the area of irritation in order to divide any nerve filaments; the outer concave

FOR ANAL FISSURE OR ULCER

In a comparatively recent case, the patient is anæsthetized—gas and air or gas and oxygen are sufficient in most cases—and the sphincters are fully stretched by the fingers; any sentinel pile or tag above or below the fissure is snipped off with curved scissors.

If the fissure is of long standing an incision is made with a straight blunt-pointed bistoury through about one-third of the thickness of the external sphincter, after both sphincters have been dilated; the incision should start a little above and end a little below the ulcer, and the outer end of the incision should extend a little more deeply than the inner. After the operation, a little cotton-wool wrung out in sublimate lotion (1–1,000) is placed in the wound, and the subsequent treatment should be conducted on lines similar to that after operation for fistula (see p. 657).



FIG. 286. ANAL FISSURE. The index-finger in the anal canal has drawn outwards a polypus at the inner end of the fissure. The fibres of the external sphincter are seen forming the floor of the fissure, also the 'sentinel pile' at its outer end.

FOR IRRITABLE ULCER OF THE ANAL CANAL

This is usually single and is situated dorsally about three-quarters of an inch above the margin of the anus.

The operation consists in forcible dilatation of the sphincter under general anæsthesia, followed by either curettage or the application of undiluted carbolic or nitric acid to the ulcer. If the ulcer be lying behind an anal valve, this must be snipped off to prevent the lodgment of fæces. If enlarged papillæ of Morgagni be present, they should be removed. The after-treatment consists in keeping the bowels easily moved, and the application of calomel ointment before and after the bowels act. It may be necessary to touch the ulcer again with carbolic acid; this may be done without an anæsthetic.

place under the use of antiseptic fomentations, and, if no extensive sloughing occurs, with no permanent detriment to the patient.

Results. The pruritus is cured and cutaneous sensation gradually returns in the operation area.

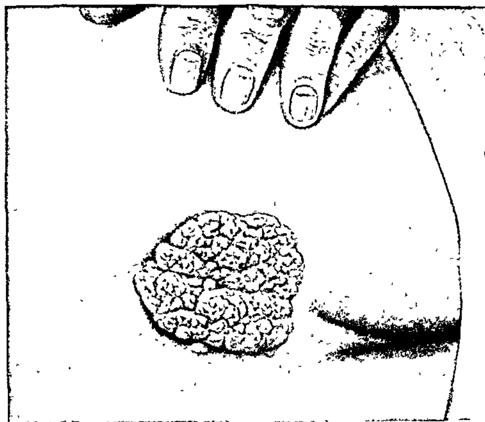


Fig. 285. Extensive Papillomata of the Anus.

FOR ANAL PAPILLOMA

When small they are best treated by the careful application of fuming nitric acid, taking care that the action of the acid is limited to the papilloma, without injury to the healthy skin. When the growths are too extensive for this treatment, as shown in Fig. 285, they should be completely cut away with scissors and their bases cauterized with pure carbolic acid, after stopping the hæmorrhage with pressure for a short time. A cyanide gauze dressing should then be applied and held in place by a firmly applied bandage.

FOR ANAL FISSURE OR ULCER

In a comparatively recent case, the patient is anæsthetized—gas and air or gas and oxygen are sufficient in most cases—and the sphincters are fully stretched by the fingers; any sentinel pile or tag above or below the fissure is snipped off with curved scissors.

If the fissure is of long standing an incision is made with a straight blunt-pointed bistoury through about one-third of the thickness of the external sphincter, after both sphincters have been dilated; the incision should start a little above and end a little below the ulcer, and the outer end of the incision should extend a little more deeply than the inner. After the operation, a little cotton-wool wrung out in sublimate lotion (1–1,000) is placed in the wound, and the subsequent treatment should be conducted on lines similar to that after operation for fistula (see p. 657).



FIG. 286. ANAL FISSURE. The index-finger in the anal canal has drawn outwards a polypus at the inner end of the fissure. The fibres of the external sphincter are seen forming the floor of the fissure, also the 'sentinel pile' at its outer end.

FOR IRRITABLE ULCER OF THE ANAL CANAL

This is usually single and is situated dorsally about three-quarters of an inch above the margin of the anus.

The operation consists in forcible dilatation of the sphincter under general anæsthesia, followed by either curettage or the application of undiluted carbolic or nitric acid to the ulcer. If the ulcer be lying behind an anal valve, this must be snipped off to prevent the lodgment of fæces. If enlarged papillæ of Morgagni be present, they should be removed. The after-treatment consists in keeping the bowels easily moved, and the application of calomel ointment before and after the bowels act. It may be necessary to touch the ulcer again with carbolic acid; this may be done without an anæsthetic.

FOR ANAL OR RECTAL ABSCESS

Under gas anæsthesia, *an anal abscess* should be opened in a line radiating from the anus, and another incision should be made across this at right angles, thus converting it into a crucial incision. The sphincter is then well dilated. The cavity of the abscess is washed out and lightly packed with cotton-wool soaked in 1–1,000 sublimate solution. This treatment is carried out two or three times daily.

For *ischio-rectal abscess* the treatment is the same as for anal abscess, but care must be taken to introduce the finger and break down all loculi; the cavity should be lightly packed with gauze to prevent the skin uniting by first intention, and hot fomentations should be frequently applied.

A *pelvic-rectal abscess* may be due to disease in the rectum itself, such as carcinoma or stricture, or to disease of neighbouring organs, viz. the prostate or seminal vesicles, or to pelvic cellulitis or peri-proctitis; it is usually situated in front of the bowel.

The patient should be given a general anæsthetic, and the abscess opened freely through the perineum or ischio-rectal fossa, according to the situation of the abscess. The left index-finger should be placed in the bowel, where it will detect the induration due to the abscess and also any condition within the bowel which may have caused the abscess. If the pus be deep seated, it should be explored for with closed forceps, which can be opened when the pus has been found, thus enlarging the aperture. The abscess cavity is then explored with another finger, all loculi investigated, and their walls broken down to form one cavity. The abscess is well irrigated with an antiseptic solution and free drainage provided for by rubber tubes. When the bowels act, care should be taken to keep the wound protected by dressings held in place by strapping.

FOR TUBERCULOUS DISEASE ABOUT THE ANUS

EXCISION OF THE TUBERCULOUS AREA

Indications. Where the patient's general health and powers of repair are good, and where the disease is of the hypertrophic papillomatous variety (see Fig. 287), and where ulceration is limited in extent and would not necessitate too extensive a removal of the skin.

Operation. The bowels should be well cleared before operation, the parts well washed, and an antiseptic fomentation applied. When

anæsthetized, the patient is turned into the semi-prone position, lying on the side to be operated upon. The parts are again washed and scrubbed with an antiseptic solution. With a sharp scalpel, two semi-

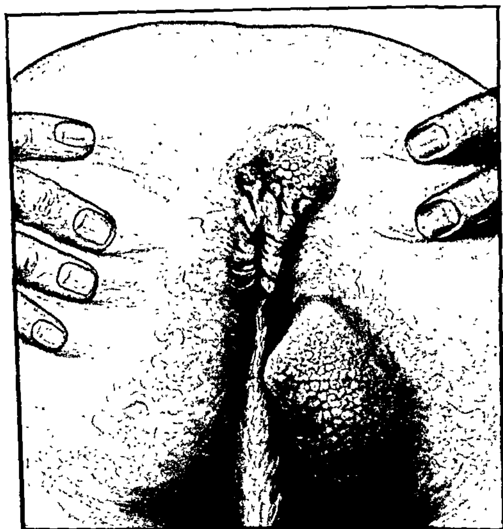


FIG. 287. HYPERTROPHIC FORM OF TUBERCULOUS DISEASE ABOUT THE ANUS. The patches are oval in shape, dusky red in colour, raised above the surrounding skin, and gradually shelving towards the circumference. The surface is covered with papillomatous-looking elevations between which there is ulceration.

lunar incisions passing through the whole thickness of the skin are made to enclose the diseased area, which is cleanly dissected away from the underlying tissues. If possible, the long axis of the wound should radiate from the anus. All bleeding points are seized with clip-forceps and twisted. When bleeding is quite arrested, the wound is completely closed with interrupted silkworm-gut sutures, the ends of which are cut rather long. The skin edges of the wound must be undercut if necessary,

to enable them to be brought together without tension. Any other diseased areas are treated in the same way. The parts should be well dried, dusted with aristol, and a collodion dressing applied.

Local anæsthesia may possibly be employed for this and the next operation.

After-treatment. The patient should remain in the recumbent position, but should, if possible, have the usual open-air treatment for a tuberculous subject.

The bowels should remain confined as long as the patient is comfortable, say six or seven days, in the hope that the wounds will have healed by first intention before the bowels act. If they have been well cleared previously to the operation, there will probably not be much difficulty about this. The administration of 10 grains of salol in powder or cachet twice daily will be of much use in the prevention of flatulence.

If the wounds do not heal by first intention, or it has not been possible at the operation to close the wound, a subsequent plastic operation for the prevention of undue contraction may be required.

Results. Where the disease has been entirely removed the results are very satisfactory.

CURETTING TUBERCULOUS ANAL ULCERS

Indications. Where the ulcers are multiple and disseminated, or where the diseased area is too extensive for excision (see Fig. 288).

Operation. The patient is anæsthetized and placed in the lithotomy position.

The lesions are then thoroughly scraped with a sharp spoon, well irrigated with an antiseptic solution, and dried. Paquelin's cautery at a red heat is then carefully applied to each wound. If the disease has spread into the anal canal, the sphincter must be dilated and the same treatment carried out.

Eucalyptus ointment, or one consisting of aristol ʒi to the ounce of vaseline, should be applied, then a piece of boric lint, wool, and a T-bandage.

After-treatment. The same position and hygienic treatment must be adopted as after the last operation. The bowels may, however, be opened in two or three days' time, when the wounds must be carefully washed with cotton-wool wrung out of an antiseptic solution, well irrigated in addition, and the same kind of dressings reapplied. Subsequently the bowels may be opened every day or other day. Every possible means must be taken to increase the patient's resisting power to the tubercle bacillus.

Results. These are uncertain. Some cases require curetting a number of times and are very difficult to cure; in others, where it is purely a local tuberculosis, a favourable result is obtained.

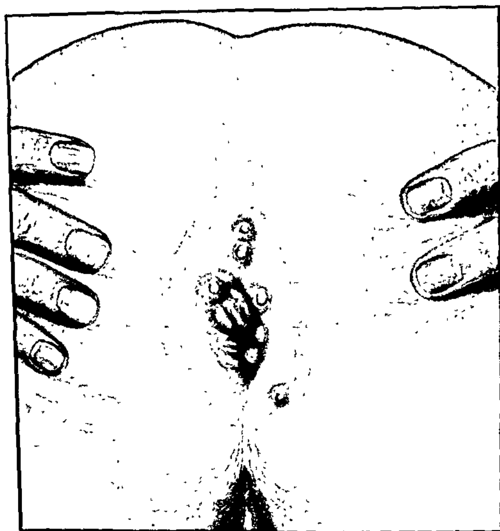


FIG. 288. TUBERCULOUS ULCERS IN THE ANAL REGION. The ulcers are somewhat circular in form, with undermined and overhanging edges and a yellowish floor.

PERINEAL EXPLORATION FOR IMPERFORATE ANUS

Indications. In all cases of imperforate anus, except where the rectum opens into the vagina or vulva by an opening large enough to allow a free escape of meconium.

Operation. The child should be enveloped in cotton-wool, anæsthetized by ether given by the open method, and the bladder emptied. It is then placed in the lithotomy position with the pelvis raised on a firm cushion.

to enable them to be brought together without tension. Any other diseased areas are treated in the same way. The parts should be well dried, dusted with aristol, and a collodion dressing applied.

Local anæsthesia may possibly be employed for this and the next operation.

After-treatment. The patient should remain in the recumbent position, but should, if possible, have the usual open-air treatment for a tuberculous subject.

The bowels should remain confined as long as the patient is comfortable, say six or seven days, in the hope that the wounds will have healed by first intention before the bowels act. If they have been well cleared previously to the operation, there will probably not be much difficulty about this. The administration of 10 grains of salol in powder or cachet twice daily will be of much use in the prevention of flatulence.

If the wounds do not heal by first intention, or it has not been possible at the operation to close the wound, a subsequent plastic operation for the prevention of undue contraction may be required.

Results. Where the disease has been entirely removed the results are very satisfactory.

CURETTING TUBERCULOUS ANAL ULCERS

Indications. Where the ulcers are multiple and disseminated, or where the diseased area is too extensive for excision (see Fig. 288).

Operation. The patient is anæsthetized and placed in the lithotomy position.

The lesions are then thoroughly scraped with a sharp spoon, well irrigated with an antiseptic solution, and dried. Paquelin's cautery at a red heat is then carefully applied to each wound. If the disease has spread into the anal canal, the sphincter must be dilated and the same treatment carried out.

Eucalyptus ointment, or one consisting of aristol ʒi to the ounce of vaseline, should be applied, then a piece of boric lint, wool, and a T-bandage.

After-treatment. The same position and hygienic treatment must be adopted as after the last operation. The bowels may, however, be opened in two or three days' time, when the wounds must be carefully washed with cotton-wool wrung out of an antiseptic solution, well irrigated in addition, and the same kind of dressings reapplied. Subsequently the bowels may be opened every day or other day. Every possible means must be taken to increase the patient's resisting power to the tubercle bacillus.

forated or the coats of the rectum may be separated. This may also take place unless great care is used with the knife. The child is in a very unfavourable condition for operation, which must not be unduly prolonged.

After-treatment. When the bowel is sutured to the margin of the anus, all that is required is to keep the part clean, and later on to gently insert the lubricated little finger for a time to prevent contraction.

Where after opening the bowel it has been impossible to attach it to the skin, troublesome contraction will follow; this must be met by the insertion of a bougie for several hours daily. If, in spite of this, the passage becomes too narrow, it must be enlarged by a backward incision, made with a blunt-pointed straight bistoury.

Results. Keith states that the prognosis is bad; an imperforate condition of the rectum appears to react unfavourably on the economy of the child even before birth, and death commonly occurs, even if the rectum be opened early. The exception is in the case of females, where the rectum opens within the vulva. In all cases hypertrophy and dilatation of the rectum follows, even if an anus be successfully established.

If the anus be closed by a membrane only, this will bulge when the child cries or when pressure is made upon the abdomen.

The membrane must be carefully divided by a crucial incision and the bowel washed out with warm water.

When the anus is imperforate or absent, and the bowel ends blindly at some distance above, an incision is made at the site of the anus, exactly in the middle line, and enlarged backwards as may be necessary, and an attempt is made to find the rectum and free it sufficiently to bring it down to the skin incision, where it should be sutured all round. It is then opened and washed out, and afterwards the mucous membrane is sutured to the skin margin, some of the sutures including the whole thickness of the bowel to prevent retraction.

If the bowel be not easily found, the dissection must be carefully deepened and at the same time carried forwards. According to Keith's opinion after his investigations of the specimens in the museums of London, it is physically possible to bring the rectum down to the perineum in 95 % of the cases. If the rectum be not found terminating at the site of the proctodæum, it will be found terminating at, or perforating, the prostate or the lower end of the vagina; if not there, then at the base of the prostate or upper part of the vagina.

The search for the bowel will be aided by the right index-finger in the wound, frequently feeling for fluctuation, while pressure is made on the child's abdomen. A trochar and canula should never be used in the search for the bowel; careful dissection alone should be employed.

If at a depth of 2 inches the bowel has not been found, inguinal colostomy (see p. 412) should be performed. In some cases the rectum has been found afterwards and brought down to the anal skin margin.

Another alternative is to deliberately open the peritoneum below by careful dissection upwards and somewhat forwards, and then search for the bowel, when it might be possible to find its blind extremity, bring it down, and fix it at or near the skin margin, the peritoneum being closed with catgut before the bowel is sutured and opened.

If a fistula which is not of sufficient size to allow of the proper escape of meconium opens into the vagina or vulva, a bent probe or director should be passed backwards through the fistula and, if possible, made to impinge on the perineum at the normal site of the anus. It is there cut down upon, and the bowel found and sutured to the skin margin.

When a fistula opens into the median raphé in the male, the same procedure should be adopted.

Dangers. There is great danger that in using a trochar and canula, Douglas's pouch, the bladder, or some coil of bowel may be per-

the simple fistula, which is the outcome of a dorsal fissure. Those which are anterior to this supposed plane generally have their internal openings immediately opposite the external and on the same side, thus constituting the simplest form of complete fistula.

Indications. Practically all cases of fistula require operation, the only exception being that of a recently formed blind external fistula, which may, though rarely, be induced to heal by injections of silver nitrate (grs. xx ad ℥i) applied by means of a small sinus syringe. As it is desirable that the bowels should not be moved for three or four days after an operation for fistula, some aperient, *e.g.* castor oil, should be given on the day but one before the operation, and a copious warm-water enema on the evening before, to make sure that the rectum is empty.

Operation. For the performance of the operation the patient should be placed on a table, lying on the side on which the fistula exists, in the semi-prone position; in the case of a horseshoe fistula and in that of perineal fistulæ, the lithotomy position is the more convenient. A general anæsthetic is most advisable, though simple fistulæ may be slit up painlessly under local infiltration anæsthesia (see Vol. I, p. 31). A probe-pointed director is passed along the track of the fistula as far as its internal opening (see Fig. 290). If this be near the anus, the forefinger of the other hand is introduced into the bowel, and the end of the director is easily made to protrude from the anus (see Fig. 291). The parts lying upon the director are then divided with a sharp bistoury. In cases of small complete fistulæ running either under or through the external sphincter, the slitting up of the fistula should be supplemented either by forcible dilatation or by complete division of the sphincter, that the part may be put more completely at rest. Great care must be taken to divide the sphincter at right angles to the direction of its fibres, or the muscle may be permanently weakened, and more or less incontinence result. Granulations or indurated tissue should be scraped or dissected away and a careful search made with a probe for any other tracks. If a bud of granulation presents after curetting, that spot probably leads to a branch and must be explored and dealt with in the same way. When the external orifice is puckered and the skin drawn in, it is advantageous to incise the floor and outer orifice of the fistula with a blunt-pointed bistoury, thus relieving all tension, and where the walls of the fistula are much indurated, one or more incisions should be made into the hardened tissues radiating from the first cut. All overlapping edges of skin and mucous membrane must be removed with scissors. When the internal orifice is an inch and a half or more from the anus, the sphincter should be forcibly dilated and a duck-bill

CHAPTER XXIV

OPERATIONS FOR FISTULA IN ANO AND RECTAL FISTULÆ: REMOVAL OF RECTAL POLYPI AND TUBERCULOUS MUCOUS MEMBRANE

OPERATIONS FOR FISTULA IN ANO

When an abscess forms in the anal or rectal region and bursts externally, and the track fails to close, it constitutes a *blind external fistula*; when there is an opening in the skin and another into the bowel, it is a *complete fistula*. Cases occur in which the internal orifice is so low down, that it can scarcely be considered to be in the bowel at all; these may be called *complete external fistulæ*. There may be two openings into the bowel, one high up, the other low down, with a simple track con-



Fig. 289. Steel Fistula Director.

necting them and no opening in the skin; this would be a *complete internal fistula*. A *horseshoe fistula* has one or more external orifices on either side of the anus, and an internal one in the middle line behind. The outer openings may be equidistant from the anus, or they may be at different distances, and placed wide from the anal orifice far out on the buttocks; and in exceptional cases a track will also run up at right angles to the main dorsal track, either outside or inside the muscular coat of the rectum, and if it opens into the bowel, the opening may be two or three inches above the anus. In such cases there will be two internal openings.

In most cases of fistula, the internal opening is single; it is within one inch of the anus; is situated dorsally in the middle line, and between the two sphincters. There seems to be a definite relation between the external and internal orifices of a fistula; for fistulæ having their external apertures situated behind a plane passing transversely through the anus, usually have their internal orifices in the middle line posteriorly, and therefore have a somewhat curved or semicircular course. This variety is called a *semi-horseshoe* fistula, the exception being

wound may be plugged with a strip of gauze, or a hollow vulcanite rectal tube may be inserted, and a long piece of absorbent cotton-wool, or gauze, introduced between the wound and the tube.

After the operation a little absorbent cotton-wool, wrung out in a 1 in 1,000 perchloride of mercury solution, should be gently placed between the surfaces of the wound. A pad of the same material is then applied to the anal region, and, over this, one or more pads of gamgee tissue, the whole being retained in position by means of a T-bandage.

Blind external fistula. A spot can generally be found where only a thin layer of tissue intervenes between the finger in the bowel and the point of the director in the track of the fistula. Through this thin layer the point of the director should be carefully pushed and the operation completed in the usual way.

Blind internal fistula. If there be a hard swelling in the anal region, an incision should be made into it, and if a probe-pointed director can then be passed into the bowel, the operation is completed as before. If there be no external signs such as swelling or induration, a well-curved probe-pointed director should be introduced into the bowel, guided by the finger, and an endeavour made to pass the director through the internal opening; if this be unsuccessful, a speculum may be used and the director passed under the guidance of the eye. The point can then be felt subcutaneously and cut down upon, and the remainder of the operation completed.

Horseshoe fistula. In operating upon a horseshoe fistula (see Fig. 292, A), it is, first of all, most necessary to recognize it, *i.e.* to understand its conformation, for a casual observer might think he had two separate fistulæ to deal with, and operate accordingly. Even were he to recognize that he was dealing with a horseshoe fistula, if he followed the usual plan, he would slit up first one sinus and then the other; thus dividing the sphincter in two places, and obliquely through its fibres, proceedings generally fraught with dire consequences to the patient (see Fig. 292, B).

If this fistula can be laid open in such a way as to entail only one division of the sphincter, and that at right angles to its fibres, there will be a minimum amount of risk of subsequent incontinence. It can be done in either of the following ways (see Fig. 292, C): (1) First pass a probe-pointed director through the internal aperture, and on its point incise the skin in the middle line behind; now push the director through, and slit up. Secondly, slit up the lateral sinuses on directors passed in at the external openings and brought out at the dorsal incision. These lateral sinuses may take either a straight, curved, or even rect-angular direction. The first incision will have divided the sphincter, but the other two will only have divided tissue external to it. (2) Should the

speculum inserted; a probe-pointed director is then passed through the fistula and an incision made on to the director from within the bowel. Great care must be exercised to keep to the fistulous track, as the point of the director is easily pushed through its wall, and this leads to the slitting up of healthy tissues and perhaps the escape of a portion of the fistula from division. If a sinus extends up above the internal aperture beneath mucous membrane only, it should be laid freely open; if it extends out-



FIG. 290. SEARCHING FOR THE INTERNAL ORIFICE OF AN ANAL FISTULA. The left index-finger is in the bowel; the probe-pointed director is held in the right hand.



FIG. 291. AN ANAL FISTULA BEING LAID OPEN. *The probe-pointed director*, which is held in the left hand, has been passed along the track of the fistula and its point brought out of the anus. A bistoury held in the right hand is dividing the tissues overlying the director.

side the muscular coat of the bowel, it is best not to divide it, but to be contented with careful curetting, especially if its division involves that of the internal sphincter, for when both sphincters are divided incontinence may follow. If the fistula be found to lead down to dead bone, most commonly the coccyx, after the fistula has been dealt with as above the bone must be laid bare, the periosteum stripped off with a raspatory, and the diseased portion removed with sequestrum forceps or gouge.

There is seldom much hæmorrhage; if any large vessel has been divided it should be ligatured. If there be profuse general oozing, the

Should the track be merely a submucous one, however, there is no objection to laying it open into the bowel.

These remarks apply equally to that minor variety of horseshoe fistula which is called the *semi-horseshoe fistula*. In these cases, the patient is placed on the side on which the external opening exists; an ordinary grooved director is passed through this opening, along the track, to a point behind the anus in the middle line; this track is then laid open. A probe-pointed director is then passed forward, from the

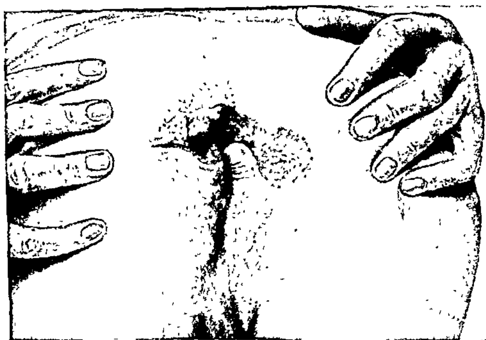


FIG. 293. HORSESHOE FISTULA FOURTEEN DAYS AFTER OPERATION.

end of the track, through the internal opening, and the sphincter and the superjacent structures are divided in the mid-dorsal line.

The operation above described may be done *à deux temps*, and if the fistula necessitates many and deep incisions, this modification will be found very advantageous. The first operation will consist in laying open all the outlying sinuses, and when these are nearly healed, it will only be necessary to make the dorsal cut through the sphincter; in other words, this second operation will be merely one for an ordinary dorsal fistula. This method, although usually necessitating two operations, has these advantages: (1) The wound after the first operation can be kept free of all fæcal contamination, as there has been no interference with the bowel; (2) in some cases it lessens the gravity of the operation; (3) there is a chance, remote though it may be, that the fistula will heal without any division of the sphincter.

external apertures be so placed that a straight line drawn from the one to the other would pass behind the anus (see Fig. 292), the steps of the operation could be reversed, and a director be passed in at one external orifice and out at the other, and the tissues divided; or if the external openings be so situated that a probe passed in at one cannot be passed out at the other, pass the director along the track to the mid-line behind the anus, and incise the tissues on to its point. Then insert the director through the external opening on the other side and pass it along the fistu-

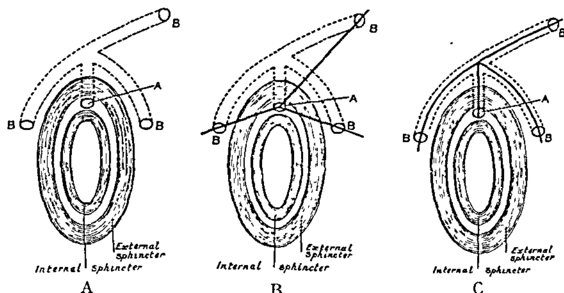


FIG. 292. HORSESHOE FISTULA. A. *Diagram of a typical horseshoe fistula with one branch.* A, Opening into the bowel, through its posterior wall; B, B, B, External openings in the skin. The dotted lines indicate the track of the fistula.

B. *Diagram showing the wrong method of operating in horseshoe fistula.* A great deal of the fistulous tract has escaped division, and the external sphincter has been divided obliquely and in three places.

C. *Diagram showing the correct method of operating in horseshoe fistula.* The whole of the fistulous tract has been laid open, and the external sphincter has only been divided once and then at right angles to the direction of its fibres. The thick lines in B and C represent the incisions in the operations.

lous track and out of the wound already made behind the anus. Now pass the director from the wound in the middle line into the bowel, through the internal opening, and slit up the tissues with the included sphincter. In this way the incisions will be found to be more or less T-shaped, the stem corresponding to the dorsal cut. In cases where a sinus extends upwards at right angles to the main track (see p. 650), it is usually outside the muscular coat of the bowel; and as its division into the bowel would involve the internal sphincter, it is best to content oneself with dilating and curetting it. Later it will probably require stimulation by injection of nitrate of silver (grs. 10 to 60 to the ounce).

examination, an attempt should be made to cure the fistula. If the disease in the lung be active and advancing, the local condition had better be left alone, or only so much done as will provide for drainage and so relieve pain. It is most important to see that the patient is put under the most favourable hygienic and dietetic conditions, and there need be no fear that the cure of the fistula will lead to increased activity of the disease in the lung.

All tuberculous granulation-tissue should be well scraped away, and if possible the sphincter should not be incised at all. The patient should not be kept in bed more than two or three days, but should lie on a couch, and if possible in the open air. Stimulant and astringent preparations may be required locally, to assist healing of the wound, such as red lotion and balsam of Peru. Many surgeons use insufflation of iodoform before applying the dressings. Aristol is an iodine preparation which, used in the same way, is probably just as effective and much more pleasant to use.

After-treatment. The dressing in the wound may be allowed to remain until it comes away when the bowels act for the first time, but if the wound be large and much packing has been inserted, boric fomentations should be applied in order to loosen it, and it may then be gradually removed, the remnant of it coming away with the first action of the bowels. Afterwards, in ordinary cases, the daily insertion of a little strip of cotton-wool (see p. 653) will suffice to keep the edges of the wound from uniting; but in more severe cases, and where deeper packing is necessary, strips of sterile gauze are to be preferred to cotton-wool. Let me here draw the attention of the reader to the best method of carrying out the dressing after the operation in an ordinary case of fistula. The finger, coated with vaseline, should first be passed into the rectum, and, whilst *in situ*, the dressing should be inserted along the finger, which thus acts as a guide. The dressing should be carried up, along the entire length of the wound, by means of a probe-pointed director, passing from the wound, at its upper limit, into the bowel, thereby ensuring that the margins of the wound are kept separate. Moreover, this method of dressing is much less painful than where, following the usual plan, a 'plug', as it is often called, is stuffed into the wound without the directing finger. I confess that I have an aversion to the term 'plugging', as applied to the dressing of wounds after an operation for fistula. For it is a well-known fact that plugging a wound retards its healing; and I have several times seen a wound which has refused to heal, although the surgeon has assured me that he had carefully plugged it every day, heal rapidly when only a light dressing has been substituted.

Internal horseshoe or circumferential fistula. In this variety the arms of the horseshoe run forwards beneath the mucous membrane: the posterior opening is situated in the mucous membrane in the mid line.

A probe-pointed director is introduced through the orifice in the mucous membrane posteriorly and made to project behind the sphincter; *in this position it lies deep to the external sphincter.* The point of the director is now cut down upon and pushed through the opening. The included tissues are now incised, the external sphincter of course being



FIG. 294. SEMI-HORSESHOE FISTULA SEVEN DAYS AFTER OPERATION.

divided. The object of this is to put the part at rest. The submucous lateral sinuses are now curetted as far as possible, and after a few days are treated by an injection of a solution of silver nitrate, 10 to 30 grs. to the ounce, applied by means of a sinus syringe. This should be repeated about twice a week.

Fistula due to tuberculous disease. The hair about the part is often unusually long and perhaps curly, the ischio-rectal fossæ are sunken in, owing to the absence of fat, and the sphincter is weak. The skin around the external orifice is bluish and often considerably undermined, the internal orifice may be large and the mucous membrane around it also undermined, and the discharge is thin and watery. The question of operation and its scope must be decided by the local and general condition of the patient. If the patient be the subject of phthisis which is quiescent, and his powers of repair appear to be satisfactory, after a general

wound, will break down and suppurate. This is most likely to take place in the deeper parts of the wound and practically the original condition is re-established, thus necessitating a second operation. If the whole of the wound breaks down it is not in a favourable condition for healing, as the skin edges will not have been sufficiently cut away, and there will be much difficulty in preventing their uniting and producing 'tunnelling' of the wound. Therefore I cannot recommend this method, although it has been somewhat strongly advocated of recent years.

When there is a sinus about the lower end of the sacrum or coccyx which does not lead to bare bone or communicate with the bowel, the sinus must be laid open and curetted, great care being taken not to touch the bone. All overhanging edges of skin must be removed with scissors, and the wound must be carefully packed with sterile cotton-wool and thoroughly dabbed with a swab soaked with sublimate lotion. In this way the wool, which fills all the interstices of the wound, becomes impregnated with the antiseptic; outside a pad is placed and held in place by a T-bandage. Boric fomentations are applied on the second day and continued till all the original dressing has come away. Dressing must be lightly inserted into the wound daily to ensure its healing from the bottom.

OPERATIONS FOR RECTAL FISTULÆ

Recto-urethral fistula. A stricture of the urethra is generally present and is the usual cause of this condition. The stricture must be cured by dilatation or urethrotomy, and this alone may suffice to close the fistula. If further measures be required, the operation is the same as for recto-vesical fistula.

Recto-vesical fistula. When the condition is due to some non-malignant process, the anus should be well dilated to obtain a good view of the rectal orifice of the fistula. If the opening be small, the actual cautery should be applied to the entire track, and possibly a posterior proctotomy may be needed to give sufficient room. If there has been much loss of substance, causing a large opening, the edges of the opening should be carefully pared while the patient is in the semi-prone position; he should then be placed in the lithotomy position and the rectum separated from the prostate and base of the bladder, through a transverse perineal incision. The opening into the bladder is closed by mattress sutures of fine silk or chromic catgut. The opening into the bowel is next closed in the same way. The sutures must avoid the mucous coat in both cases. The perineal wound is partly closed with superficial and deep sutures, and a drain is left down to the neighbourhood of the repaired fistula; this may generally be removed in

On the fourth day after operation, when the bowels have been moved, the wound should be syringed with a warm solution of either sublimate (1 in 2,000), lysoform (1 in 60), boric acid (1 in 40), or Condy's fluid (1 in 100), to remove any fæcal matter, and the syringing should be repeated after each action of the bowels. A fresh dressing should be inserted at least once daily. If the healing process goes on satisfactorily, no other dressing will be required; but if the granulations are sluggish, it will be well to stimulate the track of the wound by the use of lunar caustic, red lotion,[1] balsam of Peru, or compound tincture of benzoin. Under favourable circumstances, and provided that it has not been necessary to make a very deep incision, complete healing may be expected in about three weeks. For severe cases, six weeks to two months may be required. The patient should be kept at rest, and not allowed to walk about, until the wound has far advanced in the healing process. Fistulæ due to the presence of a foreign body, *e.g.* a fish-bone, heal up much more quickly after operation than those connected with constitutional disorders.

Resection and immediate suture. In some cases, after complete removal of the disease and irrigation of the wound, an attempt may be made to completely close the wound and get healing by first intention. Such cases are those where the patient's powers of repair are good, and especially those where it has been possible to dissect away the fistulous tract. This will only be possible in straight fistulæ, *i.e.* those in which the track has a more or less straight course between the external and internal orifices. The sphincter is first well dilated and paralysed, the fistula slit up, curetted, and if possible entirely dissected out, and the wound well irrigated with an antiseptic solution. The deeper parts of the wound are then closed by buried sutures of iodized catgut and the mucous membrane of the bowel is closed by sutures of chromic catgut. The skin and subjacent parts of the wound are closed with interrupted silkworm-gut sutures. The bowels should be opened by a dose of laxative medicine and an olive-oil enema in four or five days after operation, and afterwards they should be moved daily or every other day, care being taken to keep the motions quite soft to avoid strain on the sutures. Cases of tuberculous and of ordinary fistula have been treated in this way and have healed by first intention, and even if the whole wound does not heal at first, a considerable saving of time may result. On the other hand, the chances of a radical cure are not nearly so certain as when the wound is dressed and made to granulate up from the bottom. There is great difficulty in keeping wounds in this region aseptic, and if this is not done, some part, or the whole of the

[1] Sulphate of zinc, 2 grains; compound tincture of lavender, 15 minims; water to 1 fl. oz.

EXCISION OF TUBERCULOUS RECTAL MUCOUS MEMBRANE

Indications. Tuberculous ulceration of the lower two inches of the rectal mucous membrane, which has not improved after curetting and cauterization.

Operation. The patient is placed in the lithotomy position, the sphincter dilated, the whole circumference of the diseased mucous membrane excised, and the cut edge brought down and sutured to the margin of the anus. The details of the operation are identical with those employed in Whitehead's operation for piles (see p. 682).

After-treatment. The anus should be irrigated twice daily with an antiseptic solution, dried and dusted with aristol, and every care taken to obtain healing by first intention—a result not often attained. The bowels should be opened on the fourth day. The patient should be kept lying down till the parts have healed, but the day after operation should be carried into the open air, if possible, and the usual general treatment for tuberculosis carried out.

Results. Very satisfactory when the disease is local—much time is saved and the patient is freed from his disease.

about twenty-four hours. The external sphincter should be divided, as the paralysis produced by the preliminary dilatation of the anus will be too transient to ensure the abolition of all resistance to the passage of fæces.

After the operation the patient should be placed in the prone position and maintained in it as far as possible; a catheter is kept in the bladder for the first forty-eight hours. The bowels should be opened on the fourth or fifth day.

Recto-vaginal fistula. When the fistula is due to malignant disease, excision of the growth may be possible; otherwise colostomy will give relief. In inflammatory and traumatic cases, ulceration and stricture, if present, should first be cured or greatly improved, and subsequently a plastic operation should be performed. According to the conditions present, one of the following methods may be used: (1) Repair of the fistula through the rectum. (2) Repair through the vagina. (3) A combination of these two. (4) Complete division of the perineal body, including the fistula, followed by perineorrhaphy. (5) Separation of the rectum from the vagina by a transverse perineal incision, with repair of the fistula through that incision. Whichever method be adopted, except No. 4, it is most important to ensure that the sphincter offers no *resistance to the escape of the contents of the bowel; its complete division* is therefore advised.

REMOVAL OF RECTAL POLYPI

The small glandular polypi found in children can often be seized in forceps and twisted round and round till they come away. Other polypi, when within reach, may be removed after dilating the anus and dragging the tumour down. Its base is then encircled with a tight ligature and the tumour cut off, leaving a good stump to prevent slipping of the ligature. If the base be broad, it should be transfixed by a needle carrying a double ligature. The ligature is divided near the eye of the needle, interlocked, and each half tied tightly. The bowels should be kept at rest for three or four days, and the patient should not move about as usual till after the separation of the ligature.

When the polypus is situated too high up to be removed through the dilated anus, it may perhaps be removed by means of a snare introduced through a proctoscopic tube. When this is impossible, a posterior proctotomy will be required through a parasacral incision, with removal of the coccyx, and possibly also a piece of the sacrum: such cases, however, are very rare, as the vast majority of polypi are attached to the rectal wall within 4 inches of the anus.

Removal of prolapsed mucous membrane. *Indications.* In adults, when there is a partial prolapse of mucous membrane, often mistaken for prolapsed hæmorrhoids.

Operation. The removal may be effected either by ligaturing portions of it, as is done when operating for piles by the ligature (Salmon's operation), or by the clamp and cautery, or by Whitehead's method of removing the pile-bearing area.

The choice of these methods will depend upon the extent of the prolapse. If only part of the circumference protrudes, the ligature or clamp and cautery should be chosen, but of the two I prefer the former. In prolapse of the whole of the circumference of the mucous membrane Whitehead's operation for piles yields excellent results (see p. 682). Indeed I think it far more suited to this condition than for that for which it was originally devised, *viz.* internal hæmorrhoids, because in this condition the stitches are not nearly so likely to cut out, as there is practically no tension, whereas when done for hæmorrhoids this is considerable.

Excision of portions of skin and mucous membrane (Cheyne and Burghard). Where the anus in adults is very patulous, four diamond-shaped portions of skin and mucous membrane may be excised. A triangular-shaped portion of each is removed; the bases of the triangles meet at the margin of the anus. The sizes of the portions removed will depend on the size of the prolapse and the tonicity of the sphincter; generally more mucous membrane than skin will be removed. The wounds are closed so as to make longitudinal cicatrices parallel to the long axis of the bowel. Chromic catgut, which will hold for three weeks in muscle, should be used for the mucous membrane, and horsehair or fine silkworm-gut for the skin. The after-treatment is the same as after linear cauterization.

Injection of paraffin. In old people, where a cutting operation is not considered advisable, this certainly gives good results for a time, but publication of results has taken place too soon after operation to say whether the relief will be permanent; certainly some cases which have done well for some months have subsequently relapsed, but others have remained well for over six months after operation. The proceeding appears to be fairly simple and only attended with slight risk, and might be worthy of further trial.

Operation. The patient is anæsthetized and placed in the lithotomy position, and the prolapse is drawn down as far as possible and carefully cleansed. Paraffin having a melting-point of 113° F. is then injected in the solid state under the mucous membrane by means of a special syringe (see Fig. 295), as high up as possible (see Vol. I, p. 682). Three

CHAPTER XXV

OPERATIONS FOR PROLAPSE AND FOR HÆMORRHOIDS

OPERATIONS FOR PROLAPSE

OF MUCOUS MEMBRANE ONLY

Linear cauterization. *Indications.* In those rare instances in children where palliative measures are not successful, the best treatment is by linear cauterization with Paquelin's cautery at a dull red heat.

Operation. It is performed as follows: The patient is anæsthetized and placed in the lithotomy position. The prolapse may be cauterized before it has been returned or afterwards; in the latter case an anal speculum will be required. In the case of a child the fine point of the cautery, at a dull red heat, is drawn along a line extending from the base to the apex of the prolapse. Three or four similar lines are drawn on the mucous membrane, parallel with the first and equidistant from each other, and the prolapsed mucous membrane is returned into the bowel. If the anal orifice be unduly patulous, as is usually the case, the cautery-point should be drawn to the anal orifice, and on each side should be made to burn deeply enough to divide some of the superficial fibres of the external sphincter. A little cotton-wool smeared with vaseline or eucalyptus ointment is then introduced into the bowel.

After-treatment. The patient should be kept in the recumbent position for fourteen days. The bowels should be opened on the fourth day; a few hours previously, some ounces of olive oil should be introduced into the rectum. The patient, if a child, should be placed on his side for the action of the bowels, and it is often advisable for the nurse to draw the anus a little to one side during the act; this is done by slight traction on one buttock. If the patient be an adult he should lie on his back. These positions should be enforced at each action of the bowels for at least three weeks. In adults a larger cautery-point will be used and broader eschars made; in all cases. care must be taken not to perforate the mucous membrane. If a second operation be found necessary, the cautery should be applied to the spaces between the cicatrices resulting from the first operation.

is repaired with buried chromic catgut sutures and the dorsal incision is closed with silkworm-gut. The two lower sutures are now tied, like the upper two, over a pad of gauze. These anchoring sutures are removed after ten to fourteen days. Buried sutures of chromic catgut may be used to sling up the bowel to the tissues about the sacrum, to facilitate which removal of the coccyx may be necessary.

Ventro-fixation or sigmoidopexy. *Indications.* In cases where the bowel is reducible and prolapse of all the coats is frequent.

Operation. The abdomen is opened through the left rectus sheath. The peritoneum is divided and a strip of it, about 1 inch wide and 2 inches long, is removed on either side from the edges of the lower part of the wound. The sigmoid colon is then drawn up, care being taken to render it taut at its lower end. It is retained in apposition to the bared fascia transversalis, from which the peritoneum has been removed, by means of about four sutures of fine silk, which are passed first through the fascia on one side, then through a longitudinal band, and then through the fascia on the other side, and then tied. The peritoneum of the upper part of the wound is closed, and the rest of the wound sutured n layers.

After-treatment. The foot of the bed should be kept raised for about fourteen days. The patient should be kept recumbent for three weeks, and during the whole of this time must not be allowed to sit up to have the bowels moved, but this must always take place in the recumbent position. The bowels should be assisted to act in three days' time after the operation by means of mild laxatives and enemata, the patient being warned against any straining down. The movements should take place every two or three days afterwards.

Results. For a time these are very satisfactory, but there is a tendency for the adhesions to stretch and for the prolapse to recur.

One of my patients suffered with dragging pains in the hypogastric region after this operation, but time gradually ameliorated these. It has occurred to me that this might have been caused by tension on the fascia transversalis and peritoneum ; in future cases I should be inclined to pass the anchoring sutures through the rectus muscle and its anterior sheath, seeing that in this situation the posterior sheath is wanting. At all events this method of suture would be less likely to be followed by a recurrence of the prolapse.

In some cases of 'procidentia', when a considerable prolapse of mucous membrane precedes the descent of all the coats, and when the sphincter has lost its power of contraction, it is a good plan to combine linear cauterization with ventro-fixation, either at one operation, or in two stages with an interval of a week or two between them.

Complete excision (Mikulicz). *Indications.* As this is a

injections are made at the same level, equidistant from each other, and each consisting of 2 to 3 cubic centimetres of paraffin. At the highest level two nodules of paraffin are injected anteriorly and one posteriorly; at the next level, about 1½ inches lower down, one nodule is injected in front and two behind; at lower levels the opposite is done, and so on at each level. Three or four series of injections may be made according to the length of the prolapse. A pad is then placed over the

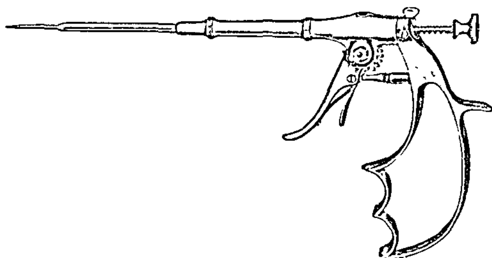


FIG. 295. SYRINGE FOR THE INJECTION OF PARAFFIN IN THE SOLID STATE.

anus and the buttocks are strapped together with rubber plaster. The patient is kept recumbent for three or four days and the bowels are allowed to act at the end of that time.

OF THE BOWEL-WALL (PROCIDENTIA RECTI)

Rectopexy. *Indications.* This operation is only suitable for a minor degree of procidentia, and is more likely to be followed by relapse than either complete excision or ventro-fixation.

Operation. The patient is placed in the semi-prone position. An incision is made from the sacro-coccygeal articulation to within 1 inch of the anus and is deepened through the levator ani till the bowel is reached; its posterior surface is cleared of fat and the bowel is drawn upwards in the direction of the sacrum. Four silkworm-gut sutures are inserted horizontally and about three-quarters of an inch apart, through the posterior rectal wall, just avoiding the mucous membrane. Then, by means of a large curved needle, the free ends of these sutures are brought out through the skin, on either side of the lower sacrum and coccyx, about 1 inch apart. The ends of the two upper sutures are tied across a pad of gauze placed over the sacrum. The levator ani

is obviated by only making very small cuts and securing the vessels at once. As the peritoneum is opened there is a risk of peritonitis, so that great care must be taken that the bowel is surgically clean before the operation is commenced. There must be no tension on the sutures or they will cut out prematurely and immediate union will fail, with likelihood of ulceration taking place and subsequent formation of stricture.

After-treatment. The patient should be kept in the recumbent position for three weeks, and during the whole of this time the bowels must act in this position. The bowels should be kept confined by opium for seven days, and before they are allowed to act an olive-oil enema should be given to soften fæcal material and diminish the strain on the sutures. The parts should be irrigated and cleansed twice daily with an antiseptic solution and dusted with aristol or boric acid, and fresh dressings applied. Light diet should be given while the bowels are confined, and 10 grains of salol given twice daily to prevent the formation of gas in the intestines.

Results. The results are generally very satisfactory; the prolapse is cured, and the patient regains control.

OPERATIONS FOR EXTERNAL HÆMORRHOIDS

Incision of thrombosed piles. *Indications.* Where the blood-clot is of recent formation, or where suppuration has taken place.

Operation. This should be done at once, as there is nothing to be gained by delay, and the relief to the pain and inconvenience is immediate.

The part should be cleansed with 1–40 carbolic lotion and 10 % cocaine solution applied on cotton-wool for ten minutes, or, if preferred, nitrous oxide gas may be administered.

The patient should be in the lateral semi-prone position, on the same side as the pile, and the upper buttock held upwards by an assistant. The point of a sharp-pointed curved bistoury is then inserted into the innermost extremity of the pile, which is rapidly transfixed and opened in a line radiating from the anus. The incision is a very superficial one, only dividing the vein-wall and the overlying skin. The black blood-clot, which is now in view, is seized with dissecting forceps and gently removed. Hæmorrhage will be trifling or absent, being prevented by a small portion of clot which remains behind. A small cotton-wool swab wrung out in 1–2,000 sublimate solution should now be applied externally, and outside this a pad of cotton-wool, the whole being held in place by a T-bandage. Some pressure should be used to aim at healing by first intention.

severe operation, it should be reserved for cases where other methods have failed, for cases where gangrene threatens, and where the prolapsed bowel is irreducible.

Operation. The bowels having been well cleared out previously, the patient is anæsthetized and placed in the lithotomy position, with the pelvis well raised on a cushion. This is done to allow the small intestine to slip up into the abdomen out of the way. The prolapse is drawn down as far as possible; it is then seized by two volsella forceps and held in this position by assistants. After the intestine has been dragged down, it is surgically cleaned and dried with sterile gauze. An incision is then made across the mucous membrane upon the anterior surface of the gut, *i.e.* through the outer layer of intestine close to the margin of the anus. This is carefully carried through the entire thickness of the intestine, all bleeding points being tied with catgut as encountered, until the peritoneal cavity is opened all round. When this has been done the bowel is drawn down as far as it will come easily, and the serous membrane of the divided outer layer of bowel is sutured to the peritoneum of the inner intestinal tube by a number of fine silk mattress sutures, the number of which will vary according to the size of the prolapse. The protruding portion of the bowel is then cut off by means of short snips with scissors, and the cut end is sutured to the margin of the anus as it is divided. The muscular and mucous coats are sutured separately by chromic catgut sutures, the ends of the latter being left long in order to steady the parts and prevent their retraction while the operation on the other portion of the circumference is being done. All bleeding points must be twisted or ligatured at once; the vessels of any size will be found posteriorly in the mesorectum.

After completing the excision, a fine continuous suture of catgut should be applied round the entire circumference if the edges of the mucous membrane be not in accurate apposition. The ends of the sutures should then be cut short and the area of operation dusted with a powder such as aristol or boric acid. A good-sized drainage tube is introduced into the rectum, and the parts round it dressed with sterilized gauze.

Difficulties and dangers. There may be a pouch of peritoneum, between the layers of the prolapsed bowel anteriorly, which may contain a loop of herniated bowel or omentum; these may easily be wounded or allowed to prolapse if the bowel be carelessly divided. The tendency to prolapse, however, is minimized by having the patient's pelvis well raised.

When the bowel is divided, hæmorrhage may be very free, but this

gives to the anus. The surgeon must also ascertain if there be any obstruction to micturition, such as stone, enlarged prostate, or stricture. Any one of these may have been the cause of the piles; and to operate first on them would be to put the cart before the horse. Stricture and malignant disease higher up the bowel must be excluded. Retention of urine frequently follows operations for piles, and if the presence of a stricture prevented the passage of a catheter, a deal of suffering and inconvenience might be caused.

REMOVAL BY LIGATURE (SALMON'S OPERATION)

It is desirable that the bowels should be cleared by aperients for two or three days prior to operation if possible. Failing this, castor oil should

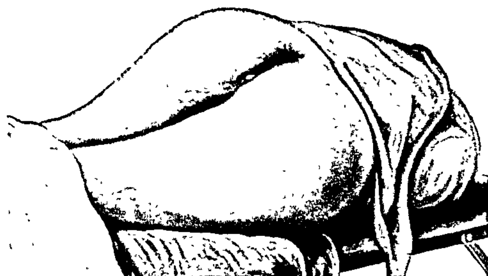


FIG. 296. PATIENT IN POSITION FOR THE REMOVAL OF HÆMORRHOIDS BY SALMON'S OPERATION.

be given about 4 p.m. on the day before operation and the bowel well washed out with warm water early the following morning, if the operation is to be done, say, about 9.30 a.m. Castor oil is the best aperient for this purpose, as its secondary astringent effect avoids dribbling from the bowel above during the operation, which is likely to take place if such a drug as sulphate of magnesia be used; care must of course be taken that the enema has been got rid of before the operation. On the evening before operation the parts about the anus should be well washed and shaved, if necessary, and a sublimate compress applied. Of course, in this as in all operations, the usual precautions against sepsis are adopted: sterilization of instruments, hands, ligatures, towels, &c., and preparation of the anal region; though naturally it is impossible to render the rectum sterile.

The operation is extremely easy and simple and presents no difficulties or dangers of any sort.

After-treatment. Rest in the recumbent position for two days is advisable but not essential, unless there is any tendency to hæmorrhage. The parts should be cleansed with an antiseptic lotion two or three times daily and the same kind of dressing reapplied. Vaseline should be inserted just within the anus by the finger before each action of the bowel in order to protect the little wound.

Where suppuration has taken place fomentations must be applied, as after the opening of an ordinary anal abscess.

Results. The patient is at once relieved and the formation of a tag of external skin is prevented.

Excision of external piles. *Indications.* In thrombosed piles of long standing when the thrombus is adherent and cannot be evacuated by a simple incision. Where external tags are either producing or keeping up pruritus ani, or are subject to recurring attacks of inflammation, or where annoyance is caused to the patient by their presence interfering with proper cleansing of the part after stool.

Operation. The patient having been prepared in the usual way and anæsthetized, each tag in turn is grasped with tag-forceps and cut off with strong scissors. Care must be taken not to cut away too much skin, or stricture will be caused; also the scissors must be so applied that the wounds radiate from the anus and leave an area of skin between each wound. Several small vessels will probably require a ligature. I do not advocate the suture of these wounds, as without it the results are excellent, and with it there is always a risk of stitch abscess.

OPERATIONS FOR INTERNAL HÆMORRHOIDS

Indications. Operative interference is not necessary in all cases of hæmorrhoids. For instance, if the piles only protrude at stool and return spontaneously after the act and are unaccompanied by much hæmorrhage, palliative treatment usually suffices; but when, on the other hand, hæmorrhage is excessive or the piles have to be replaced by the patient or surgeon, or when they are a source of annoyance owing to their protrusion during walking, such cases undoubtedly require operative interference.

Before operating for piles it is well to ascertain if the patient has any respiratory or other trouble which might entail a sitting posture after the operation, as it is a most unfavourable one for these cases. Again, a cough may be a source of much distress, owing to the jarring which it

The piles and lower part of the rectum are swabbed with cotton-wool soaked in 1–1,000 sublimate solution. Each hæmorrhoid is now seized with clip-forceps and drawn outwards, giving an excellent view of the interior of the bowel, so that it is next to impossible to overlook even a very small pile. If the usual three piles, *viz.* the right and left lateral and the perineal, only are present, I operate on the right first, as it is lower, and the bleeding from it will not obscure the others, passing on then to the perineal and left lateral; but if secondary piles are present, I operate on these first, in order that they may not be forgotten. Starting,



FIG. 298. LIGATURE OPERATION FOR HÆMORRHOIDS. *Second stage.* Each hæmorrhoid is seized with clip-forceps and drawn outwards, so that an excellent view of the interior of the bowel is obtained and even a small pile is not overlooked.

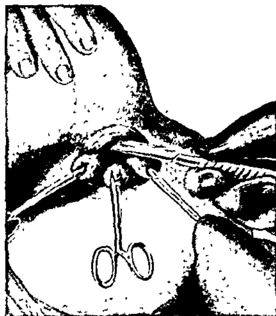


FIG. 299. LIGATURE OPERATION FOR HÆMORRHOIDS. *Third stage.* The pile is being separated from the bowel-wall by a cut made with Salmon's scissors at the junction of the skin and mucous membrane.

then, with the right lateral, the surgeon takes the forceps with which it is secured in his left hand, and raising the pile, marks the sulcus between it and the external pile if one is present, but if not, the line of junction between the skin and mucous membrane. Here, at the external circumference of the pile, an incision is made with a strong pair of spring scissors (Salmon's) with one cut, parallel to the long axis of the bowel; this incision varies in depth from half an inch to an inch, according to the size of the pile; which is thus severed from the bowel, except at its upper part, which may now be called its pedicle. An oblique cut should now be made with the scissors on each side of the pile to narrow this pedicle. These cuts start in the incision already made and pass obliquely inwards

Operation. The patient, fully anæsthetized, is placed in the right lateral prone position, with the knees well drawn up to the abdomen and the buttocks exposed to a good light. The surgeon stands or sits facing the buttocks; his assistant stands opposite to him on the same side of the table and raises the left buttock with his right hand. The surgeon now introduces his index-finger, smeared with vaseline, into the bowel and rapidly examines its entire circumference as high up as possible, to determine the presence or absence of any other lesion. The index-finger of the other hand is then inserted, and forcible dilatation of the anus



Fig. 297. Ligature Operation for Hæmorrhoids. *First stage.* Forcible dilatation of the anus. With very resistant sphincters two fingers or the thumbs of each hand may be used.

is carried out, by separating the fingers gradually and with some force; this should be continued till the resistance of the sphincter is overcome. In most females, and in all feeble subjects, but little force is necessary, and one must be on one's guard not to rupture the sphincter entirely; which may easily be done, its fibres giving way suddenly, with the formation of a hæmatoma. In females particularly is this likely to take place in front and to cause permanent loss of power in the sphincters of the anus and vagina. On the other hand, in some patients the sphincter may be unusually strong and resisting, requiring much strength and some time to overcome its resistance. In such cases the thumbs may be used or two fingers of each hand.

The surgeon must bear in mind the necessity of moderation in this part of the operation, as he is removing skin and may easily cause troublesome contraction of the anus. Here also there is usually a small vessel, which will require a ligature in each resulting wound. The ends of the pile ligatures may be cut off, leaving about 3 inches of them protruding from the anus. The index-finger is inserted well beyond any constriction caused by the ligatured piles. This constriction may be excessive, when the piles are numerous or very large; but, however well marked, it always gives way to steady pressure with the finger, which also tends to prevent any subsequent contraction. In such cases it is absolutely necessary to pass the finger a number of times, after the ligatures have come away, to prevent a stricture resulting. This trouble will rarely result if the precaution has been observed of cutting the piles pear-shaped as already described.

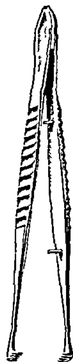


Fig. 302. Pile Forceps.

A small ⅓-inch rubber tube, with a large eye at its distal end, and a ligature threaded to its proximal end as *an anchor, is now inserted into the bowel.* The projecting end of the tube is packed round with sterilized gauze, or with swabs wrung out of sublimate solution (1–2,000); *a stronger solution may irritate the skin.* A cotton-wool pad is placed over all and is kept in position by a T-bandage firmly applied. The use of the rubber *tube has the following advantages: It enables the patient* to get rid of flatus, and so avoid the discomfort from its retention, of which so many patients complain when *no tube is used.* It reveals any hæmorrhage which may be taking place; so that concealed hæmorrhage can hardly occur. Its very presence tends to prevent oozing. Through it, 3 or 4 ounces of olive oil are injected shortly before the first action of the bowels. The tube being in position, the patient is not subjected to the pain which may accompany the passage of any nozzle or tube for this purpose.

This is the operation I am in the habit of performing; but it may be somewhat modified. For instance, when the lateral pile is enlarged by the coalescence of piles on one or both sides of it, its base may be so broad that a single ligature would not sufficiently constrict it. In such a case, I bisect the hæmorrhoid, and continue the operation as though it were two piles. Again, where external tags accompany internal piles, instead of inserting the scissors in the sulcus between the two, thus separating the tag from the internal hæmorrhoid, the scissors are applied on the flat to the skin outside the tag, at a right angle to the long axis of

towards the vessels which enter the pile from above, and lie just under the mucous membrane. The pile and its pedicle are now pear-shaped. The object of this manœuvre is to minimize the removal of mucous membrane above, and prevent the liability to stricture at a part where, without this precaution, some contraction of the lumen of the bowel is not uncommon. The assistant now takes the forceps with his left hand, whilst his right is engaged in supporting the other pair of forceps and lifting up the buttock. Whilst the assistant lifts up the pile, the surgeon lays a strong No. 10 plaited silk ligature round the pedicle and ties it



FIG. 300. LIGATURE OPERATION FOR HÆMORRHOIDS. *Fourth stage.* A pile is being drawn down and a strong ligature has been laid in the groove made by the scissors.

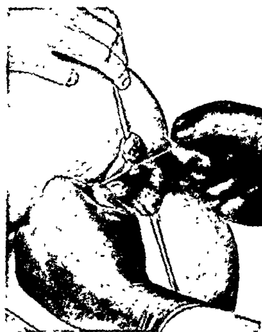


FIG. 301. LIGATURE OPERATION FOR HÆMORRHOIDS. *Fifth stage.* The ligature has been tied round the pedicle of the pile. The knot is towards the lumen of the bowel.

tightly and carefully, with the knot on the uncut mucous membrane, *i.e.* towards the lumen of the bowel. When all the piles have been thus treated, any bleeding points should be searched for, by lifting them off the several wounds. It is quite usual to find several small arterioles, branches of the inferior hæmorrhoidal artery, which run into the pile transversely, and will require tying. The ligatured piles may now be returned into the bowel. They should not be cut off, or at most only their apices; this prevents slipping of the ligatures and grave trouble from hæmorrhage. I generally use No. 10 plaited silk ligature for most piles; it should be so strong as to be unbreakable, yet not too thick. I use No. 4 silk for the smaller piles, and for vessels No. 1 twisted.

External tags or piles are now removed with tag-forceps and scissors.

oil should be given, and shortly afterwards 4 ounces of warm olive oil should be injected through the tube in the bowel, after which the tube is removed. If the patient objects to castor oil, some other suitable aperient may be given on the evening of the fourth day and the olive-oil enema administered early the following morning. Patients may use the commode, except the old and weak, who should use the bed-pan for the first two or three actions. After the bowels have been moved, the parts should be irrigated with a 1–2,000 solution of perchloride of mercury or some other suitable antiseptic, and dressings similar to those used at the operation should be applied. They should be reapplied twice daily.

As soon as the sloughs and ligatures have been cast off, the patient may leave the bed to recline on a sofa and walk about the room, and after a fortnight may walk in the open air. Sitting should be avoided as much as possible till the wounds are healed, which will generally be about the end of the third week. Soft seats should be avoided and wooden or cane-bottomed chairs should be used. The surgeon should gently introduce a finger well lubricated with vaseline into the bowel as soon as the ligatures have come away, to see if there is any contraction, and should repeat this as may be necessary. If after a fortnight the bowel be still found to be unduly constricted, the daily passage of a bougie, or dilatation with a bivalve speculum, should be carried out; with these precautions a stricture should never occur.

This operation is often followed by the formation of œdematous tags, even when all tags present at the time of the operation were excised; they generally disappear at the end of a few weeks after the application of strong lead lotion on swabs. A drachm of liq. plumbi sub acet. fort. to the ounce of distilled water is a suitable strength.

Post-operation complications. *Retention of urine.* This occurs almost equally in both sexes. One should not be in too great a hurry to pass a catheter. Many patients can retain their water for twenty-four hours, at the end of which time, or before, success may crown their efforts. Warm fomentations over the bladder and genital organs should first be tried, and if these fail a male patient may make the endeavour standing up, or a female seated on a commode. If a catheter has to be used, the strictest antiseptic precautions should be observed. The catheter should be boiled, the hands and meatus cleansed, and sterilized glycerine used as a lubricant.

Hæmorrhage. Recurrent hæmorrhage occurs a few hours after the operation, from some vessel or vessels at the outer surface of the incision, which escaped notice at the operation, or from a slipped ligature. Secondary hæmorrhage occurs when the sloughs separate. Both forms of hæmorrhage require active treatment, as the effects may speedily become serious.

the bowel, thus separating the tag as far as the sulcus ; the handles are now moved through a quarter circle, and the rest of the cut is made parallel to the long axis of the bowel. Thus the tag and the pile are included in the same ligature, and the incision will be curved or rectangular, often laying bare the external sphincter on its inferior and internal surfaces.

The points to bear in mind are: Always operate on all the hæmorrhoids, otherwise a cure will not be effected, and the operation will be discredited. In applying the ligatures, tie them as tightly as possible and knot them off securely. Never cut off the piles: at the most remove only their apices, to make sure that the constriction is absolute. Concealed hæmorrhage has often followed the practice of cutting off the piles, owing to slipping of the ligature. Always see that all bleeding has ceased before completing the operation. Do not neglect to pass the finger, both at the operation and two or three times during the three or four subsequent weeks. Neglect of this precaution may lead to a subsequent operation for traumatic stricture.



FIG. 303. LIGATURE OPERATION FOR HÆMORRHOIDS. *Sixth stage.* Rubber drainage tube surrounded by gauze or cotton-wool packing inserted after the operation for hæmorrhoids.

After-treatment. The patient must be kept quiet in bed, at least till after the ligatures and sloughs have separated, which usually occurs from the eighth to the tenth day, and low diet should be prescribed until the bowels have been moved. During the day of operation one or two hypodermic injections of morphine will be required. The bowels should be kept confined for four or five days. If they have been previously well cleared out many patients will not require any medicine for this purpose, the morphine given for the relief of pain being all that is required. If, owing to the patient's habit, anything further is thought to be necessary, a few doses of extr. opii, gr. $\frac{1}{2}$ in a pill morning and evening, will suffice. Salol, grs. x twice daily while the bowels are confined, is very useful to prevent flatulence. On the morning of the fourth day a dose of castor

by aperients and an olive-oil enema, and the patient must be warned against straining for fear of starting the hæmorrhage again.

Should hæmorrhage which requires treatment take place, say, seven or ten days after operation, it may be extremely difficult or impossible to religature the bleeding point. The 'petticoated tube' may then be used. A suitably strong tube about 6 inches long and ½ to ¾ inch in diameter, is passed so that one end projects about 1½ inches through the centre of a strong piece of sterile linen. The margin of the hole in the linen is then firmly fixed to the tube by tying a piece of silk tightly around, so that the apparatus is somewhat like a closed umbrella in shape. This end of the tube is now introduced up the bowel for about 3 inches and strips of gauze or other suitable material, which must be sterile and may be wrung out in some styptic solution, are packed in between the tube and linen, till a sufficient plug is obtained to control the hæmorrhage. A sponge of suitable size and shape with a hole through it is now slipped over the tube, and opposite sides of the linen are tied firmly over the sponge; the linen may be cut in strips to facilitate this. The tube is thus prevented from slipping up the bowel and any required degree of pressure can be applied. The presence of the tube allows flatus to pass and greatly adds to the comfort of the patient. Another method is to pass a dome-shaped Turkey sponge up the bowel, after wringing it out in an antiseptic solution and securing it by a strong ligature with two long ends passed through its apex; strips of gauze or pieces of cotton-wool well covered with powdered alum or other suitable styptic are packed in till the bowel is filled. Another sponge is placed outside the anus and between the ligatures, which are then pulled taut and securely fastened round it. In this method also, it is better to introduce a tube of some sort through the plug to allow the escape of flatus; a large gum-elastic catheter will be better than nothing. The plug should be left in as long as possible and morphine given to keep the patient comfortable.



FIG. 305. VULCANITE RECTAL TUBE IN SITU. The tube has been inserted and packed round with gauze to control hæmorrhage.

The bleeding is usually internal, and a considerable quantity of blood may be lost before the condition is suspected, unless a tube be present in the bowel, which would give warning of the condition. If the bleeding be all outside, a little extra pressure of pad and bandage may suffice to check it, but if a vessel be pumping, it should be secured with a ligature, possibly without but preferably with general anæsthesia. If there be symptoms of great loss of blood, such as quick, feeble, and perhaps intermittent pulse, great pallor, sighing respiration, coldness of the extremities, clammy sweat, restlessness, or hiccough, the surgeon should introduce a finger of either hand into the bowel and open the anus; little resistance will be experienced if the hæmorrhage has come on soon after the operation, as the sphincter will not have recovered after its forcible stretching. The opening of the orifice will be followed by the expulsion of a quantity of dark blood-clot. The pile ligatures should now be pulled outwards and downwards to get a good view of the operation area, and any bleeding points seized with forceps and ligatured. The bowel should be well irrigated to get rid of as much as possible of the clot. No special bleeding vessels may be seen, but there may be a general oozing. In this case a vulcanite rectal tube, from 4 to 5 inches in length and at least $\frac{7}{8}$ inch in diameter, should be inserted, and the bowel washed out with a warm sublimate solution (about 1 in 4,000) by means of a Higginson's syringe or a douche, to remove any high-lying clot; pressure by the hand above on the abdomen will help to clear out the clot and ensure that none of the solution is retained in the bowel. The tube, having a flange, will not slip into the bowel and is retained in position by a pad of cotton-wool and a T-bandage. If it would not entail too much delay, the patient should be given an anæsthetic, which prevents pain and enables the surgeon to do deliberately whatever is necessary without regard to the patient's feelings.



Fig. 304. Vulcanite Rectal Tube.

The tube should be left in at least twenty-four hours, both to control bleeding and to allow of the escape of old blood-clot. If the tube alone be insufficient to control the bleeding, strips of gauze or absorbent cotton-wool may be packed around it. In certain cases its use may be necessary for even three days, opium and catechu being given to prevent any action of the bowels. The tube is carefully removed by rotating it, leaving any packing, when any has been used, *in situ*. It is best not to promote an action of the bowels till several days afterwards; when this takes place the motions must be rendered quite soft

with vaseline. No action of the bowels should be permitted for twenty-four hours, and if the piles prolapse they must be immediately returned, or sloughing will probably ensue and great and unnecessary pain be caused. A mixture of the sulphates of iron and magnesia, dilute sulphuric acid, and infusion of quassia is ordered to be taken twice daily, and an ointment of subsulphate of iron (grs. x to ℥i) is passed into the bowel night and morning, and before and after each stool. A fortnight or more should be allowed to elapse before the injections are repeated, though in the majority of cases this will not be necessary.

The advantages of this method are that it does not necessitate confinement in bed or even to the house and no anæsthetic is required; it causes little or no pain, and, in my experience, no risk to life. The patient commences to get better immediately after the first injection, and is able to attend to his usual occupation during the whole of the treatment. On the other hand, with this method, one rather expects a recurrence, though to a limited extent, and possibly only after a lapse of two or three years.

Removal by clamp and cautery. **Indications.** In the absence of external hæmorrhoids this is an excellent method for removing one or at the most three internal piles. Where more are present, the necessary manipulations to clamp them are apt to break open the eschars already made and to cause bleeding, for which a ligature, or possibly several, may be needed. Several deaths from hæmorrhage are known to have occurred after this operation, and if I lived at a distance from a patient on whom I had just operated, I should feel much happier if I knew his piles were in the grip of a strong ligature than I should be had I to trust to an eschar, which might be burst open by an unlooked-for escape of flatus or motion.

Operation. In this operation each hæmorrhoid is drawn down by means of forceps and a clamp is applied to its base in the long axis of the bowel. Henry Smith's or Gowlland's clamp may be used; the latter is the less cumbersome and also has another advantage—that, on being loosened, the last portion of the seared stump to escape is the upper part, where the main vessels are situated. After the clamp has been screwed up tightly the pile is cut off with a pair of curved scissors, leaving a good stump, to which the flat surface of a Paquelin's cautery at a dull red heat is thoroughly applied. The clamp is then slightly opened to see if any blood escapes, in which case the clamp is again tightened and the cautery applied. Its hold is again relaxed, and if there be no appearance of hæmorrhage, the instrument is carefully removed.

A rubber tube well smeared with vaseline is now inserted, as in the

Although the treatment of hæmorrhage has been given somewhat fully, it rarely follows the ligature operation provided the piles are not cut off, or only a small portion of them, at the operation.

Other troubles are *ulceration, abscess, fistula, bubo,* and other results of septic absorption, all of which with proper antiseptic treatment should be avoided. *Contraction* of the mucous membrane about 1½ inches up the bowel is avoided by care at the operation, and the passage of the finger afterwards. If it be present it will yield to dilatation with the finger or bougies, aided if necessary by nicking of the constriction.

Results. After an experience of over a quarter of a century and the performance of thousands of operations for piles, I am firmly of opinion that Salmon's operation, as modified above, is the best all round operation. Recurrence after this operation when properly performed is practically unknown and risk to life must be infinitesimal, for I have never had a fatal case. I have never known it to be followed by incontinence or by stricture, where the after-treatment has been carried out as advised.

REMOVAL BY CAUTERIZATION METHODS

Application of nitric acid. **Indications.** This is only suitable for small capillary hæmorrhoids, where there is no distinct tumour.

Operation. The acid is applied with a glass brush, after the surface has been well dried and the parts around protected. No more than is necessary should be applied, and any excess neutralized with a saturated solution of bicarbonate of soda. When this has been dried off, a little oil is smeared on the part. A yellowish slough forms, which when detached leaves a superficial ulcer, which heals with a certain amount of contraction. Pure carbolic acid may be used instead of the nitric acid, but when the former is employed several applications will be probably required.

Injection of carbolic acid. **Indications.** This operation is only suitable for reducible non-inflamed internal piles, where no other rectal lesion is present.

Operation. The bowel must be empty and the piles well protruded. If this be not the case an enema is given, and when the patient has strained down he is placed on the couch on his elbows and knees. A hypodermic syringe, having a needle of good lumen, is filled with the following solution: Carbolic acid, grs. 24; glycerine and water, of each ℥i. Two to five minims are slowly injected into the centre of each pile; when the piles are unusually large two or three punctures may be necessary. After the injection swelling rapidly occurs, so that the piles must be returned as soon as possible; before this is done they should be anointed

is avoided. It will now be evident why I have stated above that I consider this method should be limited to cases where not more than three internal piles have to be treated, for it will be found that there is no room for more than the application of three clamps at the same time.

The disadvantage of this method where external piles exist is that it is not suitable for their removal owing to the pain caused by a burn of the skin in this region. They will require excision with the probable application of several ligatures to bleeding points. Therefore, if ligatures have to be used at all, I think the whole operation is best carried out by that method.

REMOVAL BY CRUSHING

Allingham's crusher is made of solid steel, and has at one end an opening, up and down which a bar of steel is moved by a screw.

Indications. For one or at most two piles this method is as good as that with the clamp and cautery. It is also suitable for anæmic and debilitated persons, as very little blood is lost. When the piles are more numerous the same objections hold good as in the previous operation.

Operation. The pile is drawn through the opening of the crusher and the bar screwed tightly home, the base of the pile being compressed in the long axis of the bowel. The pile is then cut off with scissors beyond the clamp, which is left on for about three minutes. Contraction is somewhat likely to occur unless great care be taken not to remove too much tissue with the hæmorrhoids, and where more than two piles are being treated, there is danger of a partial reopening of the crushed stumps of those already operated upon, and of causing hæmorrhage.

Results. Probably somewhat less pain follows it, and healing is even more rapid than after removal by the clamp and cautery.

REMOVAL BY EXCISION

Excision with suture (*Earle's operation*). **Indications.** Uncomplicated internal piles of moderate severity. In severe cases there will be too much risk of contraction of the anal canal. This operation has its advocates, especially abroad; but I have found that the continuous suture is not always sufficient to control the hæmorrhage, thus necessitating a reopening of the wound in order to secure the bleeding points, which of course considerably lengthens the time necessary to carry out this method. Again, the risk of suppuration or stitch abscess is by no means chimerical.

Operation. After forcible dilatation of the anus, the pile is seized in a long thin clamp in the long axis of the bowel. A curved needle, armed

ligature operation. But here it is even more important, as by allowing the escape of flatus all distension of the anal canal is avoided, thus preventing hæmorrhage due to rupture of the eschars.

Results. Cure is more speedy than after the ligature (Salmon's) operation and usually there is less pain.

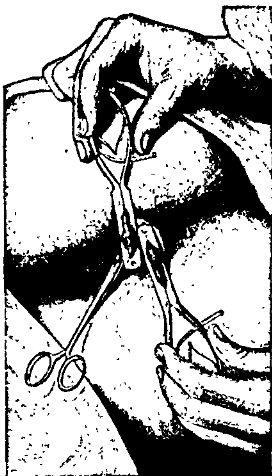


FIG. 306. REMOVAL OF HÆMORRHOIDS BY THE CLAMP AND CAUTERY. *First stage.* Two piles have been drawn down and a Gowlland's clamp applied to the base of each, in the long axis of the bowel.

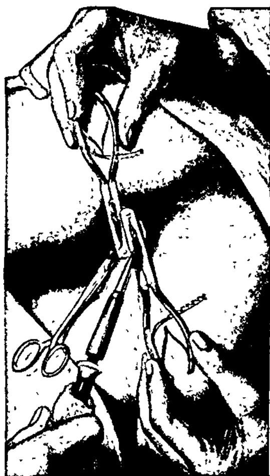


FIG. 307. REMOVAL OF HÆMORRHOIDS BY THE CLAMP AND CAUTERY. *Second stage.* Part of the piles have been cut off with curved scissors, leaving a good stump, which is being well seared with Paquelin's cautery at a dull red heat.

The smell caused by the burning is very objectionable, and special apparatus is required, and in the case of the benzoline cautery it is not always in order when it is wanted. When two or three piles are treated in this way, it is well to have as many small Gowlland's clamps as there are piles, so that there is no need to remove any one clamp until all piles have been treated; by this means any disturbance of the various eschars

of extensive and confluent piles, especially when associated with prolapse of the mucous membrane, but out of a large experience I personally have never found it necessary.

Operation. The patient, under the complete influence of an anæsthetic, is placed on a high narrow table, in the lithotomy position; the sphincters are thoroughly dilated, so that the hæmorrhoids can easily descend. By the use of scissors and dissecting-forceps the mucous membrane is divided at its junction with the skin round the entire circumference of the bowel, every irregularity of the skin being carefully followed. The external and the commencement of the internal sphincter are then exposed by a rapid dissection with blunt-pointed scissors and all bleeding vessels are immediately clamped. The whole pile-bearing area of mucous membrane, thus separated from the submucous bed on which it rested, is pulled bodily down, any undivided points of resistance being snipped across, until the hæmorrhoids are brought below the margin of the skin.

The mucous membrane above the hæmorrhoids is now divided transversely in successive stages, each vessel being clamped as it is divided. Four equidistant silkworm-gut sutures are now inserted through the skin, inner fibres of the external sphincter, and mucous membrane. The suturing is completed by the insertion of a continuous suture of iodized catgut, passing round the whole circumference, either one or two sutures being used for this purpose.

The separation of the mucous membrane from the skin should be commenced at the lowest point, and the two sides should be dealt with in succession, before completing the circle above. The incisions should be made through the mucous membrane and not through the skin. Carbolized silk is used by Mr. Whitehead for the sutures, which come away of themselves. The introduction of a suppository containing two grains of extract of belladonna, and the application to the parts of powdered iodoform or aristol, a pad of sterilized gauze, and a T-bandage, constitute the after-dressing.

After-treatment. For the first few days, with highly neurotic patients, the author of this method advises a bag of ice to be kept in close proximity to the rectum. An aperient is given on the morning of the fourth day, and the patient can resume work within a fortnight.

Whitehead contends that this method of operating is in perfect harmony with the best principles of surgery; that it can be performed with instruments always at hand; that it is a radical cure, safe as regards consequences; that the subsequent pain is comparatively slight, the loss of blood during the operation is very small, and the risks of secondary hæmorrhage less than those attendant upon the use of the clamp or ligature.

with a long catgut suture, is passed through the fold of mucous membrane just above the forceps and tied; this should include the main vessels running into the pile, which is then cut off beyond the clamp. The needle and suture are now carried over the clamp, and through the two thicknesses of mucous membrane below it, thereby sewing up the clamp with the included stump by means of a continuous suture. The clamp is now removed, the suture pulled tight and tied towards the anal margin. Before cutting off the suture it is well to see that hæmorrhage is properly controlled, as sometimes a small vessel requires ligature. The wound should heal by first intention.

After-treatment. This is the same as for Salmon's operation (see p. 674).

Robert Jones's operation. The indications for this method are similar to those for Earle's operation.

Operation. After forcible dilatation of the anus, the lowest pile is seized with pressure forceps and drawn forwards, and its pedicle is placed within a long thin clamp, similar in shape to pressure forceps, in the long axis of the bowel. The bulk of the pile is now cut away with scissors, leaving a pedicle about an eighth of an inch deep, projecting from between the blades of the forceps. A piece of No. 2 catgut about one foot in length and armed with a straight needle at each end is now taken. One needle is now passed transversely through the pedicle of the pile just beyond the tip of the forceps so as to include the vessels. The catgut is drawn half-way through and then tied with a reef-knot, so that now there are two equal lengths of catgut with a needle at each end. One needle is then passed slightly obliquely through the upper end of the stump where it projects from between the forceps; the other needle is passed at the same level, also slightly obliquely, but in the opposite direction; the two sutures are then drawn tightly and a reef-knot is tied. This is repeated till the whole of the stump is closely sutured, there being about six of these cross sutures and knots to the inch. The clamp is slackened and occasionally a small vessel at the upper end of the stump may require ligature. Each pile is thus treated in turn, the parts washed over with an antiseptic solution, and a pad placed outside the anus.

After-treatment. The same as after Salmon's operation.

Results. The results of those by whom this operation has been employed are said to be excellent. No pain is complained of and convalescence ensues without hæmorrhage or suppuration.

Whitehead's method. (Excision of the pile-bearing area.)

Indications. Anæmic and debilitated patients are not suitable for this operation. When skilfully performed it is a good operation for cases

of extensive and confluent piles, especially when associated with prolapse of the mucous membrane, but out of a large experience I personally have never found it necessary.

Operation. The patient, under the complete influence of an anæsthetic, is placed on a high narrow table, in the lithotomy position; the sphincters are thoroughly dilated, so that the hæmorrhoids can easily descend. By the use of scissors and dissecting-forceps the mucous membrane is divided at its junction with the skin round the entire circumference of the bowel, every irregularity of the skin being carefully followed. The external and the commencement of the internal sphincter are then exposed by a rapid dissection with blunt-pointed scissors and all bleeding vessels are immediately clamped. The whole pile-bearing area of mucous membrane, thus separated from the submucous bed on which it rested, is pulled bodily down, any undivided points of resistance being snipped across, until the hæmorrhoids are brought below the margin of the skin.

The mucous membrane above the hæmorrhoids is now divided transversely in successive stages, each vessel being clamped as it is divided. Four equidistant silkworm-gut sutures are now inserted through the skin, inner fibres of the external sphincter, and mucous membrane. The suturing is completed by the insertion of a continuous suture of iodized catgut, passing round the whole circumference, either one or two sutures being used for this purpose.

The separation of the mucous membrane from the skin should be commenced at the lowest point, and the two sides should be dealt with in succession, before completing the circle above. The incisions should be made through the mucous membrane and not through the skin. Carbolized silk is used by Mr. Whitehead for the sutures, which come away of themselves. The introduction of a suppository containing two grains of extract of belladonna, and the application to the parts of powdered iodoform or aristol, a pad of sterilized gauze, and a T-bandage, constitute the after-dressing.

After-treatment. For the first few days, with highly neurotic patients, the author of this method advises a bag of ice to be kept in close proximity to the rectum. An aperient is given on the morning of the fourth day, and the patient can resume work within a fortnight.

Whitehead contends that this method of operating is in perfect harmony with the best principles of surgery; that it can be performed with instruments always at hand; that it is a radical cure, safe as regards consequences; that the subsequent pain is comparatively slight, the loss of blood during the operation is very small, and the risks of secondary hæmorrhage less than those attendant upon the use of the clamp or ligature.

Comments. The objections to Whitehead's operation are somewhat numerous. In the first place, it is not easy of performance, and the time required varies from twenty to thirty minutes, and in the hands of those who have no special experience of this operation it may take even longer. Secondly, the bleeding is usually much more free than in the other methods of operating. Another objection consists in the fact that there is considerable risk of stricture of the rectum, inasmuch as the entire circumference is removed; and, when contraction does ensue, being situated at the junction of skin and mucous membrane, it is often difficult to overcome by dilatation, and may necessitate an internal proctotomy, with subsequent use of bougies for an indefinite period. The stricture follows the healing of a ring of granulation-tissue left when the sutures give way, which they more often do than not, at least in a part of the circumference. A stitch abscess, also, is by no means unknown. Another serious objection to Whitehead's operation is the loss of rectal sense, for a longer or shorter period, which occasionally ensues; and consequently the inability to appreciate the usual call to stool. Again, the difficulty in retaining flatus of which some patients complain is sufficiently distressing to make them regret that they had undergone the operation.

Mr. Anderson, House Surgeon at St. Mark's Hospital, has investigated the records of the last hundred cases of this operation performed in that institution, and informs me that complete primary union did not take place in a single case, no matter what suture material was employed. Some of the stitches cut out about the fourth day, and in many cases the whole of them, thereby leaving a large raw surface to granulate. The stay of each patient in hospital was usually between a month and six weeks, and eight had to undergo subsequent treatment for stricture.

Choice of operation. From what has been said it will be obvious that I do not recommend Whitehead's operation for piles, although it is useful in cases of prolapsus ani. In cases of any magnitude and those associated with fissure and fistula, I prefer Salmon's operation, and for slighter cases the clamp and cautery. I regret that I have no experience of Jones's operation, but the method appears to be a good one and may possibly become the operation of the future in uncomplicated cases where the piles are not too numerous. Carbolic injection cannot be looked upon as a radical cure, but is very useful in cases of uncomplicated internal piles, when it is impossible for the patient to lie up in bed.

CHAPTER XXVI

EXCISION OF THE RECTUM

Indications. This operation is seldom employed for any condition other than malignant disease of the anus or rectum. It has been done in some cases of multiple simple stricture of the rectum with extensive ulceration, when it was impossible to keep the bowel patent by means of bougies, but with very unfavourable results. Nor is it likely to be otherwise, because in these cases the perirectal tissues are much thickened by inflammatory infiltration and the bowel is bound down to surrounding parts, rendering its separation from neighbouring organs very difficult and dangerous. Moreover, in cases not amenable to other methods of treatment, it is not likely that the operator would be able to effect either a rectorrhaphy or the establishment of a normal anus; therefore in these cases colostomy and not excision should be performed.

The choice of the particular method of operation will depend upon the position and movability of the growth. A tumour situated in the anal canal should be removed by the *perineal route*; one situated between the third sacral vertebra and the upper border of the external sphincter, by the *sacro-coccygeal route*; a growth above this may require *excision by abdominal section*, or a combined *abdomino-sacral, abdomino-perineal*, or *abdomino-anal* operation. When the growth is adherent to the vagina the *vaginal route* may be employed.

Before deciding on the suitability of the case for operation, it must be ascertained if the bowel containing the growth be movable on the surrounding tissues; these are the most favourable cases. When any fixation is present the question of operation becomes much more difficult, as the growth has probably spread through the rectal wall and invaded the neighbouring parts, though it should be borne in mind that the impaired mobility may be due to inflammatory processes only. If the growth be fixed only posteriorly and there be no evidence that the nerves are involved, an operation by the posterior route may remove the extension of the disease at the same time as the primary growth. If the attachment has taken place anteriorly, complete removal becomes much more problematical, owing to the infiltration of other pelvic

viscera, such as the bladder, prostate, uterus, and vagina. Although the whole or portions of some of these may be removed with the original growth, the chances of a cure become much more remote, except perhaps where there is a small infiltration of the vagina. In these cases the conditions should be explained to the patient and friends, and if there is a reasonable chance of success an operation may be done, if particularly desired by the patient. The operation for extirpation of a carcinoma of the rectum is a severe one, and should only be undertaken if the general condition of the patient be favourable. If there be no disease of any important organ, it may be that a patient whose general condition is unfavourable may be so improved by careful dieting and intestinal lavage as to make an operation justifiable. The question of enlarged lymph glands in the mesorectum is an important one, but where only a few movable ones are found operation is justified, provided the growth also be movable. The enlargement may be merely inflammatory. If metastatic deposits are detected they negative any attempt at extirpation.

Colostomy as a preliminary measure to extirpation of the growth. Opinions have differed much as to the advisability of this procedure. Where there is sufficient obstruction to the passage of the bowel contents to prevent a thorough clearance of the large intestine prior to operation, a colostomy for this purpose is most desirable. It should be done as high up as possible in the sigmoid colon, so as not to interfere with the drawing down of the bowel at the radical operation. In order to prevent this some advise that the colostomy opening should be placed in the middle of the transverse colon. This makes cleansing of the bowel above the growth more difficult, and the cases are few where the mobility of the bowel will be so impaired as to prevent a rectorrhaphy being performed after excision, though it is quite likely to prevent the proximal end of the bowel being brought down to the anal margin after an excision, but in these cases the colostomy opening could be closed and the bowel separated from the abdominal wall. Again, in cases where it is impossible to bring the bowel down to the anus and establish proper control, a preliminary or subsequent colostomy is advisable. In all other cases a colostomy is unnecessary and subjects a patient to two or even three operations where one should suffice. It should be mentioned that some tumours which at first appeared too fixed for removal have, two or three weeks after colostomy, become sufficiently movable for a successful extirpation to be carried out. In suitable cases, therefore, a further examination should be made to see if the hoped-for improvement has taken place.

Preparatory treatment. For at least a week previous to the

excision mild aperients should be administered daily, and for four days before operation intestinal lavage should be carried out two or three times daily with a weak solution of a non-poisonous antiseptic, such as chinosol (1 in 600) or sanitas; it is also a good plan to give 10 grains of salol twice daily for the same time, to act as an intestinal disinfectant. Probably a much more effective method is to administer an active preparation of Bulgarian lactic acid bacilli, for at least a week before the operation. Care must be taken not to weaken the patient by over-purging, and he should be carefully and frequently fed with easily digested and nutritious food, leaving little residue; such as eggs, meat, breast of chicken and game, fish, tripe, liver, sweetbread, tapioca, sago, arrowroot, rice, macaroni, vermicelli, potatoes, maize, thin white toast, biscuits, pulled white bread, plasmon, protene, sugar, and butter.

EXCISION BY THE PERINEAL ROUTE (Quénu)

Indications. A malignant growth involving the anus, anal canal, and rectal ampulla, *i.e.* the dilated portion of the rectum immediately above the anal canal. Where the growth involves the anal skin, the inguinal glands are likely to be involved and will require excision at the same time or subsequently.

Operation. After being anæsthetized, the patient is placed in the lithotomy position with the pelvis slightly raised by means of a small cushion under the sacrum. The sphincter is stretched, if it is to be saved, and the rectum is well douched with a 1–4,000 solution of sublimate or biniodide of mercury or 1 in 600 chinosol, and dried. If it be possible to save the external sphincter, a circular incision is made around the anus at the muco-cutaneous junction, as in Whitehead's operation for hæmorrhoids; if the sphincter be involved in the disease, the circular incision must be made in the skin outside the anus. A circular cuff of mucous membrane is now dissected up and a stout silk ligature tied tightly round it, to prevent contamination from the interior of the rectum. The end of the stump is then disinfected by being rubbed over with liquefied carbolic acid or the actual cautery. The incision is now carried exactly in the mid-line forwards nearly to the scrotum and backwards to the tip of the coccyx, the external sphincter being divided behind and retracted with the skin. The median incision is deepened till the muscular coat of the bowel is exposed, as it will be after the fibres of the levator ani, which unite in the mid-line, have been cut through. The circular incision is then deepened, and the levator ani on each side is cut through, after it has been defined by passing the left index-finger under it from the median incision; this is done with blunt-pointed

scissors close to the bowel. All bleeding vessels must be seized at once and ligatured when convenient. By blunt dissection and the aid of the scissors where necessary, the bowel is freed behind, at the sides, and in front. If the patient be a male, a metal sound in the urethra held well up under the pubes is of much service at this stage in defining this passage and so preventing injury to it; great care must also be taken not to injure the bladder or ureters. In the case of a female, an assistant's finger in the vagina is a useful guide.

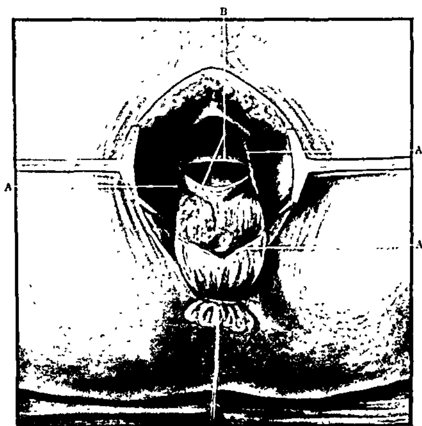


FIG. 308. EXCISION OF THE RECTUM BY THE PERINEAL METHOD. The bowel is freed from the levator ani, A, A, A, and the peritoneum, B, has been opened. A ligature has been tied tightly round the lower end of the bowel.

After careful separation anteriorly to a depth of 2½ to 3 inches the peritoneal reflexion is displayed; it may be necessary to divide this in front and laterally to get well above the growth and draw healthy bowel down to the skin. The mesorectum should be divided close to the sacrum, to prevent injury to the middle hæmorrhoidal artery and to remove the glands. In some cases it may be possible to peel the peritoneum off the rectum without opening it, but it may be then difficult to bring the cut end of the bowel down to the skin without tension. The parietal peritoneum is now sutured with a continuous fine silk stitch to the rectal

wall and the opening in the peritoneum is closed, while an assistant is pulling the bowel downwards and backwards. This stitch also tends to prevent retraction of the bowel, which on the proximal side of the growth will now have been so much pulled down that it will be on a level with the anus. The rectum is clamped well above the line of section with suitable forceps, having their handles directed backwards out of the way, and is cut across at the level of the skin and a good inch above the growth. If no clamp be used, the vessels are caught and ligatured as they are divided. The end of the bowel is united to the skin by interrupted sutures of silkworm-gut, which pass through all the coats. The clamp is now removed and any bleeding point ligatured. If the sphincter has been preserved its divided extremities must be carefully united by buried sutures of chromic catgut and the skin sutured with silkworm-gut, allowing for efficient drainage before and behind. The cut edges of the levator ani are sewn to each other with chromic catgut sutures, both before and behind the bowel, and also to the wall of the latter. It is important to insert a large rubber tube into the bowel, which can be maintained in place by one or two silkworm-gut sutures. Antiseptic dressings are then applied in the usual way.

Difficulties and dangers. When the peritoneum is not opened there is often difficulty in loosening the upper rectum sufficiently to bring it to the skin. When the peritoneum is opened the chief difficulty is in separating the bowel and arresting hæmorrhage in the depths of the wound. Great gentleness must be employed in separating the tissues behind the bowel and care taken to keep close to the sacrum, so as not to injure its blood-supply, or sloughing will result. There is considerable risk of excessive loss of blood in this operation; this must be avoided by securing every bleeding vessel at once. Other dangers are injury to the bladder, urethra, seminal vesicles, and ureters; these are prevented by careful dissection and avoidance of tearing.

After-treatment. Means must be taken to combat shock, if present, and morphine administered hypodermically to relieve pain. The wound must be kept clean and sweet by irrigations two or three times daily with antiseptic solutions, after which the parts are dried and dusted with an antiseptic powder, such as aristol, and dressings reapplied. The patient should be frequently fed with small quantities of nutritious, easily digested food. In the absence of troublesome flatulence and discomfort the bowels should be moved about seven days after operation. An aperient should be given by the mouth and a warm olive-oil enema given before the bowels act. It is very important, if the sphincter has been preserved and sutured, to prevent the passage of hard scybala. If the patient has difficulty in emptying the intestine, he must be directed

not to strain down, and if a lubricated finger gently inserted confirms the presence of hard motions which have not been softened by the oil enema, it is a good plan to add a drachm of purified ox-gall to a pint of warm water and slowly inject this into the bowel. If the ox-gall has become hard it should be rubbed down in a small quantity of boiling water first. The ox-gall solution should be retained for half an hour or more to allow the motions to become softened; it should then be allowed to escape, and afterwards the bowel carefully washed out with a soap-and-water enema, or the oil should be again administered if the ox-gall has not been quite successful. Afterwards an aperient should be given every other day and the same precautions against straining adopted.

Complications. *Septic troubles,* which are to be avoided by careful emptying and cleansing of the bowel previous to operation and avoidance of infection of the wound. *Stricture,* owing to giving way of the sutures. This will be treated by dilatation with the finger and bougies, and is to be avoided by keeping the wound aseptic, by not tying the sutures too tightly, and the avoidance of tension. *Urinary fistula* is avoided by taking care not to injure the urinary tract. If present, a fistula may close spontaneously or it may require a plastic operation later on. *Gangrene of the stump* is prevented by avoiding injury to the superior hæmorrhoidal artery. To do this great gentleness must be exercised in separating the bowel high up behind and by keeping close to the sacrum. *Prolapse of the mucous membrane;* if this causes inconvenience, it should be removed by an operation similar to Whitehead's for piles.

Results. This operation is attended with a low mortality, but is usually followed by some incontinence if the bowels are at all relaxed, even when the external sphincter has been preserved. This is owing to injury either to the muscle itself or its innervation.

EXCISION BY THE SACRO-COCCYGEAL ROUTE (Kraske)

Since Kraske first introduced his method of removing the coccyx and a small piece of the left side of the sacrum, along a line commencing at the left side of the sacrum, at the level of the third posterior sacral foramen, curving inwards and downwards through the fourth left posterior foramen to the left lower corner of the sacrum, various modifications have been suggested, the main feature of each being the position in which the sacrum is divided. Thus Bardenheuer divides the whole of the bone below the third foramina, others have removed the bone below the second foramina. Heinecke turned the lower end of the sacrum and

FIG. 309. PARASACRAL EXCISION OF THE RECTUM. *First stage.* The coccyx and lower part of the sacrum having been exposed by means of a median longitudinal incision, the sacrum is being divided transversely with a chisel.

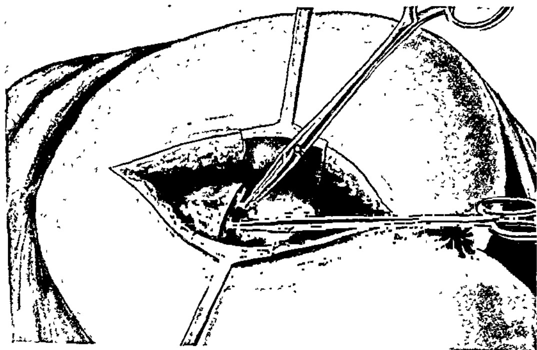


FIG. 310. PARASACRAL EXCISION OF THE RECTUM. *Second stage.* The coccyx and part of the sacrum have been removed and the sacra media vessels caught in clip-forceps; under the forceps is the rectum surrounded by the perirectal tissues.

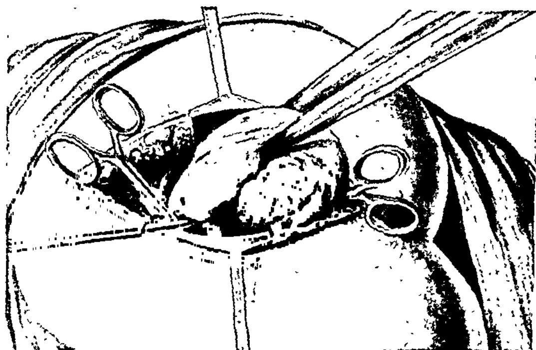


FIG. 311. PARASACRAL EXCISION OF THE RECTUM. *Third stage.* The rectum is being pulled out of the wound by a fold of gauze, after the peritoneal cavity has been opened on either side. Between the gauze and the lower angle of the wound is the portion of cancerous bowel about to be excised.

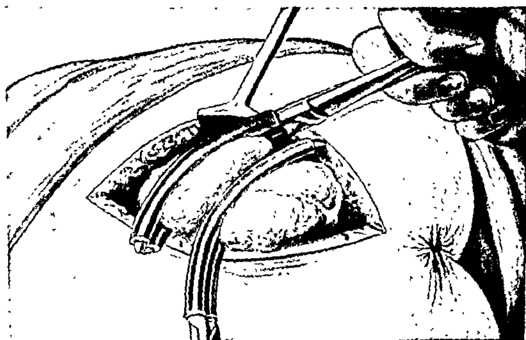


FIG. 312 PARASACRAL EXCISION OF THE RECTUM. *Fourth stage.* The bowel is held by two rubber-covered clamps at least an inch above the growth, and is about to be divided between them.

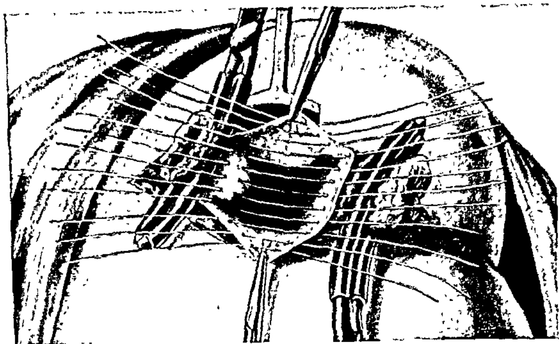


FIG. 313. PARASACRAL EXCISION OF THE RECTUM. *Fifth stage.* The excision has been carried out, and the upper and lower ends of the bowel are shown clamped. Compression forceps are pulling apart the opened peritoneal cavity in order to fix it, thus facilitating the insertion of a series of interrupted silk sutures.

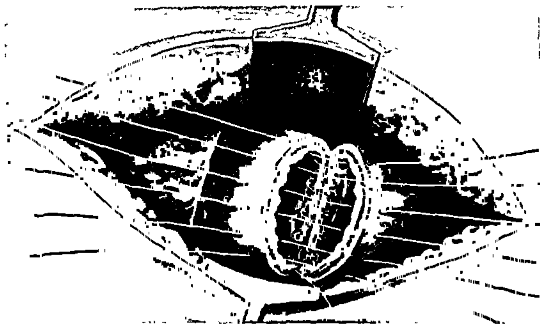


FIG. 314. PARASACRAL EXCISION OF THE RECTUM. *Sixth stage.* The anterior half of the circumference of the bowel has been united by sutures. Sutures are inserted to unite the posterior portion; they have been passed through all the coats of the bowel and will require another row to bury them. This is an alternative way to that described in the text.

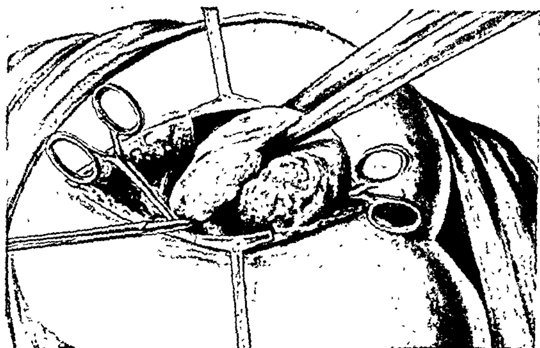


FIG. 311. PARASACRAL EXCISION OF THE RECTUM. *Third stage.* The rectum is being pulled out of the wound by a fold of gauze, after the peritoneal cavity has been opened on either side. Between the gauze and the lower angle of the wound is the portion of cancerous bowel about to be excised.

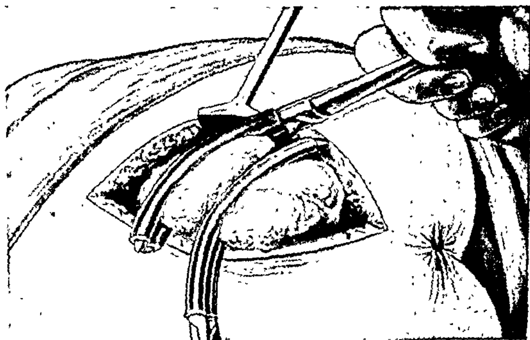


FIG. 312 PARASACRAL EXCISION OF THE RECTUM. *Fourth stage.* The bowel is held by two rubber-covered clamps at least an inch above the growth, and is about to be divided between them.

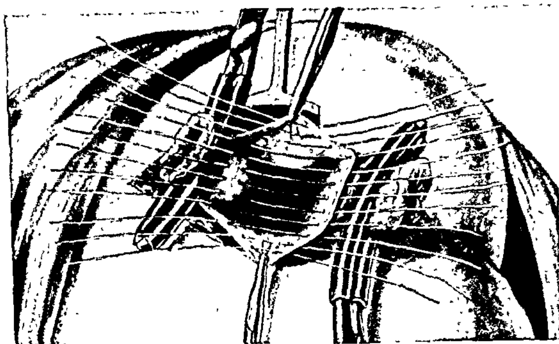


FIG. 313. PARASACRAL EXCISION OF THE RECTUM. *Fifth stage.* The excision has been carried out, and the upper and lower ends of the bowel are shown clamped. Compression forceps are pulling apart the opened peritoneal cavity in order to fix it, thus facilitating the insertion of a series of interrupted silk sutures.

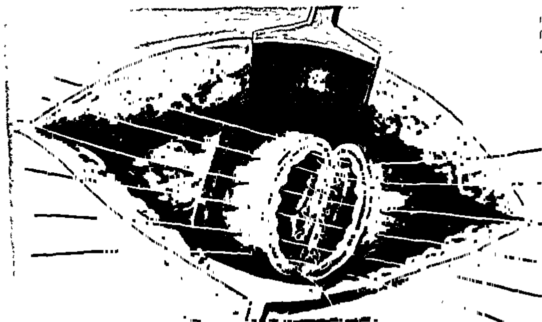


FIG. 314. PARASACRAL EXCISION OF THE RECTUM. *Sixth stage.* The anterior half of the circumference of the bowel has been united by sutures. Sutures are inserted to unite the posterior portion; they have been passed through all the coats of the bowel and will require another row to bury them. This is an alternative way to that described in the text.

coccyx outwards on a hinge formed by the sacro-sciatic ligaments and replaced them at the end of the excision; necrosis is, however, liable to take place in this operation, but this is not nearly so likely to occur if the bone is not wired, but is held *in situ* by catgut sutures passed through the soft structures only. Kraske now advises removal of the coccyx only, unless additional room be required, and this is the procedure which should be adopted.

Indications. For malignant growth which extends up as high as the middle of the sacrum.

Operation. The whole operation area having been prepared and an antiseptic compress applied the day previously and again on the morning of the operation, the patient is anæsthetized and placed in the left lateral position with the pelvis well elevated. The patient may be in Littlewood's kneeling position, with the pelvis well raised and the lower extremities supported on a chair, or on his right side, or in the lithotomy position with a sand-bag under the lumbar spine and the thighs well flexed; but I prefer the first. The anal sphincter is stretched and the rectum is washed out with 1 in 600 chinosol solution through a bivalve speculum. A median vertical incision is then made from the middle of the sacrum to just behind the anus, and deepened till the sacrum and coccyx are exposed. The amount of bone to be removed depends to a large extent upon the position of the growth as found at a previous examination, and in many cases the removal of the coccyx alone is all that is required. If this be not sufficient, the soft parts are peeled off from either side of the sacrum and coccyx, and the ligaments attached to either side divided. The bone is cleared on its anterior surface with a blunt dissector, the sacrum is cut through transversely with a chisel and mallet, and the part below the cut is removed. This is done at some point below the level of the third posterior sacral foramina, according to the room required. In this way it is usual to remove 1 or 2 inches of the sacrum or even more. If hæmorrhage takes place it is arrested, but difficulty may be experienced in securing the lateral and middle sacral vessels with forceps, as they may retract under the bone and be difficult to seize. Rather than waste time by many endeavours to ligature these vessels at this stage, bleeding may be controlled by firm pressure with a gauze tampon on the part of an assistant, whilst the operation is continued. For the more convenient ligature of these deeply-placed vessels I have devised a compression forceps combining the advantages of Greig-Smith's shape with that of Lawson Tait (see Fig. 315). The shape is that of Greig-Smith's with transverse serrations, for I found that Greig-Smith's forceps were apt to sever the vessel, thereby rendering a second application of the ligature necessary on a much shortened and retracted vessel.

The tissues in the mid-line behind the rectum are now incised in a vertical direction till the levator ani is reached, when the latter is divided on either side with scissors. With very little further separation of the perirectal tissues with the fingers, the bowel is exposed and the upper and lower limits of the growth are defined. It is well not to attempt to dissect out the bowel too freely from its bed of perirectal fat, by which much bleeding is avoided and the lymphatic paths from the growth remain undisturbed. Separation of the posterior and lateral walls having been chiefly effected with the aid of the finger, it remains to deal with the anterior. The position of the growth will now determine the next stage of the operation, the object being to remove the growth with at least an inch of healthy bowel above and below it and to reunite the cut ends of the upper and lower segments by circular suture; or to bring the lower end of the upper segment through the lumen of the lower segment and unite the former to the margin of the anus, after removing the mucous lining of the lower segment. It may be possible to draw the bowel down far enough without interfering with the peritoneum, or, after stripping it upwards off the front of the bowel, without opening it, but in the majority of cases the peritoneum must be opened. It is found at the upper part of the wound by blunt dissection and is opened close to the bowel for fear of injuring the ureters. Its anterior and lateral reflections are divided to a sufficient extent, and the mesentery of the rectum is divided close to the bone to avoid injury to the blood-supply of the bowel. At the same time the glands and connective tissue are separated from the hollow of the sacrum as far as may be necessary. When the bowel can be drawn down far enough, the peritoneum is closed with interrupted catgut sutures, and sutured to the bowel; this tends to prevent retraction. The bowel is then divided an inch or inch and a half above the growth between two clamps or two pieces of tape or thick silk tied tightly round it; at the back is seen the divided superior hæmorrhoidal artery, which is ligatured. The lower segment of the bowel is then freed in front from above downwards. It is much easier to do this from above downwards than from below upwards; there is also less hæmorrhage.

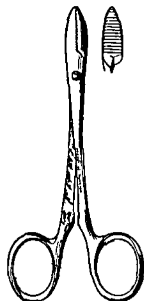


FIG. 315. COMPRESSION FORCEPS. (*Author's pattern.*)

An assistant's finger in the vagina, or a steel sound in the male urethra, will make the separation of the bowel from the organs in front safer. Care must be taken, by careful packing with gauze, that there is no

coccyx outwards on a hinge formed by the sacro-sciatic ligaments and replaced them at the end of the excision; necrosis is, however, liable to take place in this operation, but this is not nearly so likely to occur if the bone is not wired, but is held *in situ* by catgut sutures passed through the soft structures only. Kraske now advises removal of the coccyx only, unless additional room be required, and this is the procedure which should be adopted.

Indications. For malignant growth which extends up as high as the middle of the sacrum.

Operation. The whole operation area having been prepared and an antiseptic compress applied the day previously and again on the morning of the operation, the patient is anæsthetized and placed in the left lateral position with the pelvis well elevated. The patient may be in Littlewood's kneeling position, with the pelvis well raised and the lower extremities supported on a chair, or on his right side, or in the lithotomy position with a sand-bag under the lumbar spine and the thighs well flexed; but I prefer the first. The anal sphincter is stretched and the rectum is washed out with 1 in 600 chinosol solution through a bivalve speculum. A median vertical incision is then made from the middle of the sacrum to just behind the anus, and deepened till the sacrum and coccyx are exposed. The amount of bone to be removed depends to a large extent upon the position of the growth as found at a previous examination, and in many cases the removal of the coccyx alone is all that is required. If this be not sufficient, the soft parts are peeled off from either side of the sacrum and coccyx, and the ligaments attached to either side divided. The bone is cleared on its anterior surface with a blunt dissector, the sacrum is cut through transversely with a chisel and mallet, and the part below the cut is removed. This is done at some point below the level of the third posterior sacral foramina, according to the room required. In this way it is usual to remove 1 or 2 inches of the sacrum or even more. If hæmorrhage takes place it is arrested, but difficulty may be experienced in securing the lateral and middle sacral vessels with forceps, as they may retract under the bone and be difficult to seize. Rather than waste time by many endeavours to ligature these vessels at this stage, bleeding may be controlled by firm pressure with a gauze tampon on the part of an assistant, whilst the operation is continued. For the more convenient ligature of these deeply-placed vessels I have devised a compression forceps combining the advantages of Greig-Smith's shape with that of Lawson Tait (see Fig. 315). The shape is that of Greig-Smith's with transverse serrations, for I found that Greig-Smith's forceps were apt to sever the vessel, thereby rendering a second application of the ligature necessary on a much shortened and retracted vessel.

colostomy has been done, to subject the patient to this procedure at a later date.

Difficulties and dangers. Much the same remarks apply here as after the last operation, although the loss of blood is generally distinctly less. Fæcal contamination of the wound is particularly dangerous during this operation. General septic infection may follow, also necrosis of the sacrum and prolonged suppuration. It must be avoided by devoting sufficient time to the clearance of the bowel before operation and the careful use of clamps and packing during its performance.

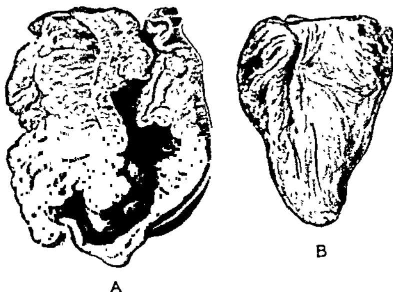


FIG. 316. PARTS REMOVED IN PARASACRAL EXCISION OF THE RECTUM. A, Sagittal section of the carcinomatous bowel after removal; the healthy mucous membrane above the growth has folded backwards and is therefore barely shown; B, Posterior view of the coccyx and portion of the sacrum removed in parasacral excision of the rectum from the same case.

After - treatment. The patient will have to be kept lying on his side, and much the same treatment must be carried out as after the last operation.

Great care must be taken by an intelligent nurse to prevent contamination of incisions and sutures when the bowels act; the parts should be protected by dressings held by the hand or kept in place by strapping, and careful cleansing must be carried out with an antiseptic solution and drying as often as may be necessary.

If a sacral anus has been formed the bowels may be opened on the fourth day. Later on, a truss to control the opening is advised by some, but in my experience the patients find them irksome, inefficient, and often painful and soon discard them.

Complications. Septic infection of the wound may be followed by necrosis of the sacrum, if a portion of that bone has been removed. If the bowel has been united by circular suture, the stitches may give way posteriorly, leading to the formation of a fæcal fistula; this is usual, but in the majority of cases it will close spontaneously. Stricture of bowel frequently follows circular suture. This will be overcome by

contamination of the wound when the bowel is opened, but if the bowel has been properly prepared beforehand, and especially if a previous colostomy has been done, there is not much risk of this taking place. When the bowel has been freed for at least an inch below the growth, it is divided between two clamps. If now the upper segment can be brought down far enough, and there is sufficient bowel left above the sphincters in the lower portion to allow of it, the cut ends are united by circular rectorrhaphy. This is done in two layers, using silk for the fibro-muscular layer, sewing the anterior half of the circumference first. The mucous coat is then united with No. 2 28-day chromicized catgut sutures, knotted on the inner surface. Finally, the posterior half of the fibro-muscular coat is sutured with fine silk. A few extra sutures are put in if any part of the junction appears to need additional support. The whole operation area is now well irrigated with warm 1–4,000 perchloride of mercury lotion. A large rubber tube, 6 inches long, ¾ inch in diameter, is inserted into the bowel, its upper end well above the suture line, and the posterior wound is closed, buried sutures of catgut being used when needful to bring the surfaces together and obliterate spaces in which exudation might collect and decompose. Efficient drainage is provided for by one or more rubber tubes and strips of sterilized gauze. In order to prevent strain on the bowel sutures, the anus is first well stretched and the external sphincter divided subcutaneously.

In some cases the mucous lining of the anal canal is removed and the lower end of the upper segment is drawn through the sphincters and sutured to the skin; when this can be done without tension it is a very good method. When it is impossible to bring the upper bowel down to the anus or to do a circular rectorrhaphy, its lower end is sometimes sutured to the upper part of the cutaneous incision, forming a sacral anus. Before this is done the bowel should receive a half or three-quarter twist on its longitudinal axis, enough to hinder somewhat the introduction of the finger into the bowel; this to some extent improves the patient's power of control of the bowel contents in some cases. The existence of a sacral anus, however, is a trouble and annoyance to the patient; he has little or no control over the fæcal evacuation, which is projected backwards instead of downwards. The opening is in such a position that it is difficult for him to attend to the cleansing of it and a subsequent prolapse of the bowel is likely to cause great annoyance. A sacral anus, therefore, compares very unfavourably with that of an iliac colostomy, for here the opening can be looked after by the patient himself, whilst a considerable amount of control is afforded by the surrounding abdominal muscles, when the operation has been efficiently performed. It may, therefore, be necessary, when no preliminary

colostomy has been done, to subject the patient to this procedure at a later date.

Difficulties and dangers. Much the same remarks apply here as after the last operation, although the loss of blood is generally distinctly less. Fæcal contamination of the wound is particularly dangerous during this operation. General septic infection may follow, also necrosis of the sacrum and prolonged suppuration. It must be avoided by devoting sufficient time to the clearance of the bowel before operation and the careful use of clamps and packing during its performance.

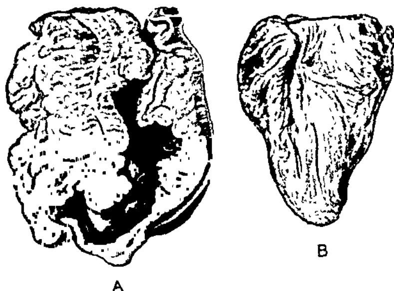


FIG. 316. PARTS REMOVED IN PARASACRAL EXCISION OF THE RECTUM. A, Sagittal section of the carcinomatous bowel after removal; the healthy mucous membrane above the growth has folded backwards and is therefore barely shown; B, Posterior view of the coccyx and portion of the sacrum removed in parasacral excision of the rectum from the same case.

After - treatment. The patient will have to be kept lying on his side, and much the same treatment must be carried out as after the last operation.

Great care must be taken by an intelligent nurse to prevent contamination of incisions and sutures when the bowels act; the parts should be protected by dressings held by the hand or kept in place by strapping, and careful cleansing must be carried out with an antiseptic solution and drying as often as may be necessary.

If a sacral anus has been formed the bowels may be opened on the fourth day. Later on, a truss to control the opening is advised by some, but in my experience the patients find them irksome, inefficient, and often painful and soon discard them.

Complications. Septic infection of the wound may be followed by necrosis of the sacrum, if a portion of that bone has been removed. If the bowel has been united by circular suture, the stitches may give way posteriorly, leading to the formation of a fæcal fistula; this is usual, but in the majority of cases it will close spontaneously. Stricture of bowel frequently follows circular suture. This will be overcome by

the careful passage of Hegar's dilators, gradually increasing the size. The removal of too much of the sacrum has caused meningitis with a fatal result.

Results. I have performed this operation sixty-seven times with three deaths, one from peritonitis, one from septicæmia, caused by the wound being flooded by fæcal material, and one from bronchitis and heart failure; the last thirty-three cases have all recovered. Where rectorrhaphy has been carried out, the functions of the bowel have been completely restored, the patients having a normal action and perfect control. This also applies where the upper bowel was brought down through the sphincters and sutured to the margin of the anus; these cases recover quicker than the others, as no fæcal fistula forms. Recurrence must of course depend to a great extent on the malignancy and extent of the growth at the time of operation. Of my first sixty cases *of parasacral excision it has been possible to trace fifty. Recurrence* took place in eighteen of these—in one after eight years, one after four years, one after three years, in eight after two years, and in seven within the year. Twenty-six were known to be in good health—one after fourteen years, two after four years, four after three years, ten after two years, and nine after one year from the time of operation.

EXCISION BY THE ABDOMINAL ROUTE

When the growth is situated sufficiently high up to be excised completely and the divided ends of the gut reunited by a simple abdominal section the tumour will be found to be situated in the sigmoid colon and not in the rectum proper. Excision of the sigmoid has been described by Mr. Makins (see p. 465).

ABDOMINO-SACRAL OR COCCYGEAL EXCISION

Indications. Where the growth is situated so high up, *i.e.* at the junction of the rectum and sigmoid colon, that it would be impossible to free the bowel above it sufficiently through a parasacral incision.

Operation. The patient should be prepared as for an abdominal section and placed in the Trendelenburg position. An incision is made through the left rectus sheath, the muscle drawn outwards, and the abdomen opened. An examination is now made of the extent, position, and connexions of the growth. If the growth be very extensive, and especially if it involves the lower rectum to within an inch of the sphincters as well as the upper rectum, a rectorrhaphy would be impossible and removal of the whole of the rectum and part of the sigmoid would have to be carried out. The pelvic cavity is carefully packed off with abdo-

minal cloths. The bowel, well above the growth, is divided between two intestinal clamps placed several inches apart, or between two india-rubber ligatures made of thin drainage tube passed completely round the bowel. The blood-vessels in the divided mesentery and bowel are secured. A Paul's tube is fixed into the upper bowel, which is sutured into the upper part of the wound to form an artificial anus, and the open end of the tube is plugged with gauze. The peritoneum of the mesentery of the bowel is carefully divided with scissors on each side from above downwards. The bowel and the growth and the tissues behind it, with any contained glands, are carefully peeled downwards to the pelvic floor, taking care not to injure the ureter or the iliac vessels. The peritoneum, where it is reflected off the bowel in front, is divided with scissors. The free end of the separated bowel is now sterilized with liquid carbolic acid and closed by a continuous silk suture through all the coats; this is inverted by a second continuous silk suture passing through the peritoneal and muscular coats. This careful closure of the bowel is to prevent contamination of the wound during the subsequent manipulations. The separated bowel is now, if possible, pushed down below the cut peritoneum, the divided edges of which are brought together by a continuous silk suture. The abdominal packing is now removed, a final inspection made to see that no oozing is taking place, and the abdominal incision closed. The table is now slowly lowered till it is horizontal and the patient placed in the left lateral position with the pelvis raised, and the operation is completed by removing the lower part of the rectum as described under Kraske's operation on p. 690. When the operation is completed, the gauze plug is removed from the Paul's tube; a rubber tube of large calibre is then slipped on to its end to convey away the bowel contents to a vessel under the bed.

Where the growth is limited and does not involve the lower three or four inches of the rectum, a rectorrhaphy may be possible. The steps of the operation will then be as follows: The abdomen is opened and the rectum and sigmoid freed as described above, till a portion of the latter is reached, which can be drawn downwards sufficiently to enable it to be sutured through the parasacral incision to the bowel below, after the growth has been removed. After repair of the peritoneum, the abdomen is closed and the operation is completed as described under Kraske's operation. It may be possible to so free the sigmoid loop as to bring it down to the anus without tension and with a good blood-supply; this will depend on the length of its mesentery. The best plan would then be, after removal of the growth, to dissect away with scissors the mucous lining of the anal canal and the lower segment of the bowel, which should be about 2 inches in length. A pair of forceps is then

passed up through the anus, and the end of the sigmoid is seized and drawn down to the anal margin, where it is sutured as described under the abdomino-anal operation.

Difficulties and dangers. The same as are met with in Kraske's operation, and in addition there is more risk of contaminating the peritoneum and of injuring the left ureter and large vessels in the pelvis, and shock is generally severe. To avoid these the abdominal wound should be well retracted and the operation done with a good overhead light to enable the surgeon to see exactly what he is doing. All manipulations within the abdomen should be as gentle as possible, and there should *not be any dragging on the bowel or mesentery. The patient* must be well covered and the temperature of the operating room should not be under 70° F.

After-treatment. This is carried out on the same lines as after Kraske's operation and abdominal section.

Results. This operation is a very severe one and is attended with a high mortality, probably about 50 %.

ABDOMINO-PERINEAL EXCISION (Quénu)

Indications. In cases of extensive disease, necessitating removal of the entire rectum with the sphincters.

Operation. Some days previously to the operation for excision of the rectum a sigmoid colostomy (see p. 412) is practised. Through this the bowel below is thoroughly emptied and irrigated with some non-poisonous antiseptic solution. The patient is placed in the Trendelenburg position and the abdomen is opened through the left rectus sheath near the middle line, and both internal iliac arteries are ligatured. The peritoneal cavity is protected by abdominal cloths, the artificial anus is liberated from the abdominal wall, and the bowel cut completely across with the thermo-cautery. The cut ends are disinfected with a strong antiseptic and enveloped in iodoform gauze. The upper end is brought out through the wound in the iliac region and sutured there, forming a permanent artificial anus

It would be safer now to completely close the cut end of the lower portion of bowel with sutures, to prevent any risk of soiling the peritoneum during the latter part of the operation. The lower portion of *the bowel is now freed by division of its mesentery* as described under the abdomino-sacral operation. The freed bowel is wrapped up in iodoform gauze and pushed down to the bottom of the pelvis. The cut edges of the peritoneum on the floor and posterior wall of the pelvis are drawn together at this stage, if possible, with a continuous silk suture, and if all hæmorrhage has been arrested the abdomen is closed.

The patient is now placed in the lithotomy position and the perineal operation is carried out as described on page 687. The freed bowel and its gauze wrapping are removed through the perineal wound, and if the peritoneum of the pelvic floor has not been completely closed this should now be done. The wound is now well flushed with 1 in 4,000 sublimate lotion. A good-sized drainage tube is inserted and the cut levatores ani muscles are brought together by No. 2 chromic catgut sutures, which will remain in the tissues about three weeks before being absorbed. The rest of the wound should be approximated by buried sutures as much as possible, to avoid pocketing, and the skin wound united with interrupted sutures of silkworm-gut, with their ends cut long, to facilitate removal and prevent pricking of the patient's skin, which happens if the ends are cut short. The perineal dressing is applied and secured by a T-bandage, that on the abdominal wound by a many-tailed bandage.

Difficulties and dangers. These are practically the same as after the abdomino-sacral operation, except that, the bone not having been injured, necrosis is avoided.

After-treatment. This is the same as described under the abdomino-sacral and perineal operations.

Complications. These and the means of combating them have been discussed under the abdomino-sacral and perineal operations.

Results. The mortality is high, especially amongst men, probably about 40%.

ABDOMINO-ANAL EXCISION

Indications. When a malignant growth of the rectum extends too high up for removal by Kraske's operation, and where the sigmoid colon can be brought down to the anus, without tension or interference with its blood-supply.

Operation. The patient is placed in the Trendelenburg position. An incision is made through the left rectus sheath, the muscle drawn outwards, and the abdomen opened. The longest portion of the sigmoid colon is found, and if it will reach to the anus without tension, it is divided at the extremity of the loop, between two clamps or ligatures, and the ends protected with gauze tied in position to prevent contamination of the peritoneum. The mesosigmoid is divided below the level of the bowel section after being clamped, and the vessels are tied. The mesorectum is divided close to the sacrum and lower down its peritoneal reflections are divided close to the bowel. The rectum is separated before and behind by blunt dissection as far as the floor of the pelvis,

passed up through the anus, and the end of the sigmoid is seized and drawn down to the anal margin, where it is sutured as described under the abdomino-anal operation.

Difficulties and dangers. The same as are met with in Kraske's operation, and in addition there is more risk of contaminating the peritoneum and of injuring the left ureter and large vessels in the pelvis, and shock is generally severe. To avoid these the abdominal wound should be well retracted and the operation done with a good overhead light to enable the surgeon to see exactly what he is doing. All manipulations within the abdomen should be as gentle as possible, and there should not be any dragging on the bowel or mesentery. The patient must be well covered and the temperature of the operating room should not be under 70° F.

After-treatment. This is carried out on the same lines as after Kraske's operation and abdominal section.

Results. This operation is a very severe one and is attended with a high mortality, probably about 50%.

ABDOMINO-PERINEAL EXCISION (Quénu)

Indications. In cases of extensive disease, necessitating removal of the entire rectum with the sphincters.

Operation. Some days previously to the operation for excision of the rectum a sigmoid colostomy (see p. 412) is practised. Through this the bowel below is thoroughly emptied and irrigated with some non-poisonous antiseptic solution. The patient is placed in the Trendelenburg position and the abdomen is opened through the left rectus sheath near the middle line, and both internal iliac arteries are ligatured. The peritoneal cavity is protected by abdominal cloths, the artificial anus is liberated from the abdominal wall, and the bowel cut completely across with the thermo-cautery. The cut ends are disinfected with a strong antiseptic and enveloped in iodoform gauze. The upper end is brought out through the wound in the iliac region and sutured there, forming a permanent artificial anus.

It would be safer now to completely close the cut end of the lower portion of bowel with sutures, to prevent any risk of soiling the peritoneum during the latter part of the operation. The lower portion of the bowel is now freed by division of its mesentery as described under the abdomino-sacral operation. The freed bowel is wrapped up in iodoform gauze and pushed down to the bottom of the pelvis. The cut edges of the peritoneum on the floor and posterior wall of the pelvis are drawn together at this stage, if possible, with a continuous silk suture, and if all hæmorrhage has been arrested the abdomen is closed.

the operation is concerned. The subsequent steps of the operation are simple and devoid of danger.

After-treatment is the same as after an abdominal section, but in addition the anus will require irrigation and cleansing several times daily. The patient need not be confined to any particular position, and the bowels should be opened on the third or fourth day after operation.

Results. The mortality is not so great as after any of the other combined operations. The nursing is much simpler and convalescence is more rapid. The patients have perfect control of the bowel.

Choice of combined method. The abdomino-sacral operation should only be selected where the lower rectum is free from disease and a rectorrhaphy through the sacral incision can be carried out, and where the mesentery of the sigmoid is not sufficiently long to allow that portion of the bowel to be brought down to the anus.

Where this can be done after a laparotomy, I prefer the abdomino-anal operation, because it is less severe, as no bone is removed, also it is not attended with the risk of fæcal fistula or stricture.

The abdomino-perineal operation is the method of choice where it is necessary to remove the entire rectum with the sphincters, for where the disease is so extensive, the probability is that there will be some obstruction present, necessitating a preliminary colostomy. It must, however, be rarely called for, as where the disease is so extensive it has already passed beyond the walls of the rectum and excision will be out of the question.

Although Quénu ligatures the internal iliac arteries, I think it is unnecessary and only adds to the gravity of the operation. It might be remarked that in the performance of a parasacral excision difficulties may be met with in separating the bowel high up above the growth, and necessitating a laparotomy to enable this to be carried out. This combined operation will then be sacro-abdominal, instead of abdomino-sacral. The risk of this is, however, greater, because it takes longer and the position of the patient has to be changed twice.

EXCISION BY THE VAGINAL ROUTE

Indications. This is a very good operation in cases of early growth in the lower end of the rectum, also in those where the vagina is involved in the growth.

Operation. The rectum having been emptied and both it and the vagina well douched previously, the patient is placed in the *lithotomy* position and the rectum and vagina are again washed out with an antiseptic solution. The walls of the vagina are drawn apart with broad retractors,

all glands being removed with the bowel. A ligature is placed tightly round the bowel just above the levator ani and well below the growth. The portion of bowel below the ligature is then irrigated through the anus with an antiseptic solution by an assistant, the bowel is divided below the ligature by means of curved scissors with long handles, and the freed bowel, *i.e.* the rectum and the sigmoid up to where it was divided, is removed.

The cut edges of the divided peritoneum are united by a continuous silk suture and any bleeding points are secured. The patient is now put into the lithotomy position. The lower end of the rectum is then pulled down by forceps passed up through the anus, turned inside out, and its mucous membrane dissected away. A pair of forceps is again passed up through the anus and made to seize the ligatured end of the proximal portion of the sigmoid; this is drawn down through the anus and sutured to the skin. *An assistant may close the abdominal wound while this is* being done; if it be closed by the surgeon he should wear rubber gloves to avoid contamination of the wound. A large drainage tube is passed up the bowel.

It will be noticed that the sigmoid colon is divided without reference to the position of the growth, but at that portion of the loop where the mesentery is long enough to permit the bowel to be drawn down to the anus without tension.

If the growth be not too large the procedure may be modified, as was done in a case reported by my friend and colleague Mr. Aslett Baldwin (*British Medical Journal*, July 18, 1908). The rectum, with the growth and the sigmoid up to the longest portion of its loop, was freed through an abdominal incision. The anus was then forcibly dilated by an assistant and a long pair of sponge forceps passed up the bowel as far as the growth. A tape was then tied tightly round the bowel just below the expanded end of the forceps. By traction on these forceps and by means of a hand within the pelvis, the bowel and the included growth were drawn and pushed down till a long intussusception projected from the anus; this was cut off beyond the anus and the ends united by sutures and returned. The patient, a woman aged 29, made a good recovery and has perfect control. A few weeks previously, she had colostomy performed for obstruction of ten days' duration. Before the bowel could be drawn down sufficiently, the colostomy opening had to be closed and the sigmoid freed from the abdominal wall. A drainage tube was left in the lower end of the abdominal incision for a few days; no other drainage was used. Of course this method is only applicable when the growth is comparatively small.

Difficulties and dangers. These are the same as after the combined operations already described as far as the pelvic portion of

sutures. The former method of dealing with the end of the bowel is the safer because of the risk of extravasation of bowel contents in circular suture. If the latter method be used, an incision should be made in front of the coccyx and a drainage tube inserted into the hollow of the sacrum, so as to reach to just below the suture line in the bowel. A rubber drainage tube ½ inch in diameter should also be passed up the bowel, and should reach beyond the suture line and project at least 1 inch beyond the anus. It should be retained in position by silkworm-gut sutures passed through the anal skin. The sphincters should be well stretched, and it is safer to divide the external sphincter in order to lessen the strain on the sutures when the bowels are moved.

Difficulties. These are practically the same as after the perineal operation, and the same care must be taken during the after-treatment to avoid giving way of the sutures as after Kraske's operation, when rectorrhaphy has been carried out. The vagina should be douched twice daily with an antiseptic solution.

Results. These have been very good, particularly where the bowel can be brought down through the sphincters and sutured to the margin of the anus. Convalescence is rapid, and some cases have been well within a fortnight.

PARTIAL INCISION

In some early cases when the growth is limited to a small portion of the posterior or postero-lateral wall, or even the anterior wall in females, it is justifiable to expose the bowel by the coccygeal or vaginal route and remove the affected portion of the bowel by an oval incision; this can then be sutured either transversely or longitudinally, provided too great a contraction of the bowel be not thereby produced. The risk of this operation is much less than that of complete excision, but great care must be taken to ascertain that the growth, which when viewed from the mucous surface appears well defined and limited, has not extended laterally in the submucous and muscular coats; this would of course necessitate a complete resection.

Some authorities state that early recurrence is the rule after partial excision, but my experience is more fortunate. I have operated in this way four times and as yet there has not been a recurrence. The first case was well after more than ten years, the second and third after three years, and the fourth after two years. The diagnosis of carcinoma was verified in each case by a microscopical examination.

the anterior lip of the cervix uteri is seized with a volsella, and the uterus is drawn downwards and forwards. An incision is then made in the posterior wall of the vagina, from near its upper end above, and deepened below through the perineum till the external sphincter is exposed but not divided. If the vaginal wall be not implicated by the rectal growth, it is easily peeled back on either side and the bowel exposed; but if infiltration has commenced, the affected part must be enclosed in an elliptical incision and removed with the bowel. The rectum is now freely exposed, the levator ani divided, and the neighbouring structures freed from the bowel by blunt dissection; posteriorly the fat and glands are separated from the sacrum with the bowel. If the growth be sufficiently low down it may suffice to push up the peritoneum of the pouch of Douglas; if not, it must be opened and its lateral reflections divided, together with the mesorectum, close to the bone and as high up as necessary. In separating the bowel above the growth great care must be taken to avoid injuring the superior hæmorrhoidal artery at the posterior aspect of the bowel.

The opening in the peritoneum is now closed by sutures or packing; the former should include the bowel to assist in preventing retraction. The growth is removed by division of the bowel at least an inch above and below the tumour, care being taken to prevent contamination of the wound by clamps or rubber or tape ligatures. After removing the ligature on the distal segment, the anus is dilated and the mucous membrane lining the lower segment is removed from the anal margin upwards, and the lower end of the upper segment is drawn bodily through the collar thus formed, and, after removing its occluding ligature, is sutured with interrupted silkworm-gut sutures to the skin round the anus. Should there be difficulty in drawing down the upper bowel to the anus, and if there be sufficient bowel left above the sphincters for the purpose, the bowel can be united by circular suture. The anterior wall of the lower segment is divided in its long axis, for an inch or so, to facilitate the circular suturing of the two ends; this is begun at the posterior aspect and continued round on each side, taking up all the coats of the bowel. Interrupted No. 2 28-day chromic catgut sutures are used, which are tied on the inner aspect of the bowel. The small vertical incision is then sutured.

When the bowel has been dealt with, any packing removed, and the peritoneum closed by sutures, if this has not already been done, the wound is irrigated with a warm antiseptic lotion, the incision in the vagina is closed with No. 2 14-day chromic catgut sutures, and the perineum repaired. The sutures closing the vagina should include the muscular coat of the rectum, to prevent retraction and lessen the strain on its

sutures. The former method of dealing with the end of the bowel is the safer because of the risk of extravasation of bowel contents in circular suture. If the latter method be used, an incision should be made in front of the coccyx and a drainage tube inserted into the hollow of the sacrum, so as to reach to just below the suture line in the bowel. A rubber drainage tube ½ inch in diameter should also be passed up the bowel, and should reach beyond the suture line and project at least 1 inch beyond the anus. It should be retained in position by silkworm-gut sutures passed through the anal skin. The sphincters should be well stretched, and it is safer to divide the external sphincter in order to lessen the strain on the sutures when the bowels are moved.

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CHAPTER XXVII

OPERATIONS FOR STRICTURE OF THE RECTUM

PRIOR to subjecting a patient to any of these operations, care should be taken to ensure a thorough evacuation of all intestinal contents, for which purpose a week is often needed; during this time, in addition to the administration of purgatives, frequent enemata should be given; and, if they do not pass above the stricture, it can usually be dilated sufficiently to enable them to do so, but if ineffective, a preliminary colostomy is certainly called for. The bowel should be well irrigated with non-poisonous antiseptic solutions. Intestinal antiseptics should be given by the mouth, such as salol, gr. 10 twice daily; if procurable, the Bulgarian lactic acid bacilli are more effectual. The diet should be the same as that recommended after operation.

DILATATION BY BOUGIES

Indications. As in the analogous condition of the urethra, favourable conditions for treatment are more likely to be present—

(i) In recent cases.

(ii) When the stricture is low down and of slight or moderate extent.

(iii) When adjacent parts are not involved.

Operation. The dilatation must be conducted with great care on the part of the surgeon, and it is necessarily a tedious process, generally requiring several months for its accomplishment. No force should be used in introducing the bougie, especially when the stricture is in that part of the bowel which is covered by a reflection of peritoneum. Neglect of this precaution has been followed by fatal results, due to rupture of the peritoneal coat. The gum-elastic instruments are of various sizes, and the conical form is the most suitable. Of late years, I have found conical metal dilators, such as gynæcologists use for dilatation of the cervix uteri, which are known as Hegar's dilators, of much service. These dilators have either a single or a double curve, which greatly facilitates their passage. Moreover, they can be easily sterilized. The cases in which I have found these dilators of special use are those in which a narrowing of the rectum has taken place, owing to the formation of an anterior spur after rectorrhaphy following the operation for removal of malignant disease.

Supposing that the stricture is within 3 inches of the anus, a bougie of suitable size, previously warmed and well lubricated, should be passed through it and allowed to remain *in situ* for at least half an hour. The patient should be kept in bed, and the introduction of the bougie should be repeated on each succeeding day until the stricture is permeable to its full extent; a bougie of the next larger size should then be used, and so on until the requisite amount of dilatation is effected.

In the case of annular stricture, near the anus, this dilatation may be facilitated by making a few *incisions* through the indurated tissues, and by using Todd's dilator (see Fig. 317) or a bivalve speculum. These incisions should not be too deep, and three or four are usually sufficient. As some hæmorrhage always occurs, a hollow vulcanite tube, open at

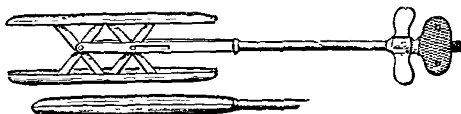


FIG. 317. TODD'S RECTUM DILATOR.

both ends, should be introduced, and retained for forty-eight hours. Subsequently a bougie is passed daily, and afterwards a dilute solution of potassium permanganate, chinosol, or boric acid should be used as an injection.

In cases in which the stricture is beyond the reach of the finger, the difficulties are much increased. The bowel should be carefully examined by means of the proctoscope or sigmoidoscope. The position, length, and other characters of the stricture having been ascertained, attempts may be made to dilate it by passing a conical bougie through a Kelly's proctoscopic tube, the patient being in the genu-pectoral position. When the point of the instrument has entered the stricture, it will be more or less closely gripped thereby; no force is permissible, as there are several cases on record in which the bougie was driven through the bowel, with fatal peritonitis as a result. Peritonitis, indeed, may be set up in the absence of perforation. When the stricture has been reached, the bougie should be allowed to remain *in situ* for a few minutes or even longer, the proctoscopic tube being withdrawn over the bougie. The patient is of course to be kept in bed and at rest, and all due precautions must be adopted with regard to diet.

Difficulties and dangers. Rupture of any of the coats of the bowel may be followed by proctitis, periproctitis, or peritonitis.

These are to be avoided by introducing instruments of suitable size with the utmost gentleness, and by devoting sufficient time for the proper emptying and cleansing of the bowel before operation, and by antiseptic irrigations afterwards.

After-treatment. The patient should be kept in bed, at least till dilatation is well advanced, and the bowel should be irrigated several times daily with non-poisonous antiseptic solutions. The diet should consist of food which will leave little residue, such as has been recommended to be given before excision of the rectum on p. 687.

The above remarks on dangers and after-treatment also apply to the following operations for stricture of the rectum.

When dilatation is accomplished, the patient's symptoms are much relieved, the bowels act more comfortably and regularly, and with little or no straining. It must, however, be remembered that a relapse is very liable to occur, unless the bougie be passed at regular intervals for some months or years after the dilatation has been effected. The patient's diet also requires careful attention, and everything which tends to irritate the bowels must be avoided. Constipation, if present, is to be dealt with by laxatives, such as castor oil or the compound liquorice powder. If there be dyspepsia and flatulence, bismuth and soda are indicated.

LINEAR INCISION

Indications. This is the best method we have for dealing with annular strictures of the linear variety when situated well within reach of the finger, *i.e.* anywhere below the peritoneal reflection.

Operation. The patient being in the lithotomy position, the sphincter should be forcibly dilated. The left index-finger is then passed up to or through the stricture, carrying with it a probe-pointed straight bistoury; and three or four limited incisions are made through the stricture, dorsally, bilaterally, and even anteriorly. A sheathed Todd's dilator is then introduced, and the blades expanded to the requisite extent, *i.e.* in most cases sufficiently to permit the introduction of a No. 10 conical rectal bougie; and the operation is completed by the insertion of a No. 8 or 9 hollow vulcanite tube with a flange (see Fig. 304). This maintains dilatation, arrests bleeding by pressure, discloses concealed hæmorrhage if present, and permits the passage of flatus. It should be retained, if possible, for at least forty-eight hours. As a rule, but little bleeding takes place at this operation; but, if the bleeding should be at all severe, any bleeding vessels should be secured and tied: should this not be possible, such bleeding can be arrested by firmly plugging

with gauze strips, using the vulcanite tube as a *point d'appui*. This operation is particularly fitting for low-lying strictures of traumatic origin, such as sometimes follow an operation for hæmorrhoids.

After-treatment. This consists in the daily passage of a bougie, and irrigation with some antiseptic fluid through the bivalve speculum, until the wounds have healed. The passing of the bougie may then take place at increasing intervals.

INTERNAL PROCTOTOMY

Indications. It should be employed in strictures higher up the rectum, when of an annular or limited tubular form.

Operation. This is really a similar operation to the foregoing; but one incision only is made, in the mid-line dorsally. This incision should cut through the whole thickness of the stricture. The steps of the operation, and the after-treatment, are the same as above detailed; except only that to avoid the locking-up of secretions in a large and deep incision it is as well not to rely upon forcible dilatation of the anus, but to substitute a subcutaneous division of the external sphincter. In this operation, if bleeding be not sufficiently arrested by the vulcanite tube, the addition of tampons of gauze will usually prove effectual.

EXTERNAL PROCTOTOMY

Indications. Where there is a considerable quantity of inflammatory thickening surrounding the strictured portion of the bowel.

Operation. The strictured part of the bowel is divided longitudinally through a dorsal skin incision, the patient being in the left semi-prone position. If necessary, the coccyx and even the lower segment of the sacrum may first be excised. The strictured bowel is then freely divided by a longitudinal incision in the middle line. Buried chromic catgut sutures are then passed through the superficial layers of the gut, the wound in the bowel closed longitudinally, and the skin wound closed, with provision for drainage. In this way, the cicatricial tissue which forms the stricture is left ununited. A drainage tube should be inserted through the anal canal, and retained there, to provide for the escape of flatus and discharges.

Results. The only drawback to this operation is that a fæcal fistula is often the result, which may necessitate a plastic operation for its closure. Its advantages are that the sphincter is not divided, and that, the wound being open, hæmorrhage is easily controlled.

These are to be avoided by introducing instruments of suitable size with the utmost gentleness, and by devoting sufficient time for the proper emptying and cleansing of the bowel before operation, and by antiseptic irrigations afterwards.

After-treatment. The patient should be kept in bed, at least till dilatation is well advanced, and the bowel should be irrigated several times daily with non-poisonous antiseptic solutions. The diet should consist of food which will leave little residue, such as has been recommended to be given before excision of the rectum on p. 687.

The above remarks on dangers and after-treatment also apply to the following operations for stricture of the rectum.

When dilatation is accomplished, the patient's symptoms are much relieved, the bowels act more comfortably and regularly, and with little or no straining. It must, however, be remembered that a relapse is very liable to occur, unless the bougie be passed at regular intervals for some months or years after the dilatation has been effected. The patient's diet also requires careful attention, and everything which tends to irritate the bowels must be avoided. Constipation, if present, is to be dealt with by laxatives, such as castor oil or the compound liquorice powder. If there be dyspepsia and flatulence, bismuth and soda are indicated.

LINEAR INCISION

Indications. This is the best method we have for dealing with annular strictures of the linear variety when situated well within reach of the finger, *i.e.* anywhere below the peritoneal reflection.

Operation. The patient being in the lithotomy position, the sphincter should be forcibly dilated. The left index-finger is then passed up to or through the stricture, carrying with it a probe-pointed straight bistoury; and three or four limited incisions are made through the stricture, dorsally, bilaterally, and even anteriorly. A sheathed Todd's dilator is then introduced, and the blades expanded to the requisite extent, *i.e.* in most cases sufficiently to permit the introduction of a No. 10 conical rectal bougie; and the operation is completed by the insertion of a No. 8 or 9 hollow vulcanite tube with a flange (see Fig. 304). This maintains dilatation, arrests bleeding by pressure, discloses concealed hæmorrhage if present, and permits the passage of flatus. It should be retained, if possible, for at least forty-eight hours. As a rule, but little bleeding takes place at this operation; but, if the bleeding should be at all severe, any bleeding vessels should be secured and tied: should this not be possible, such bleeding can be arrested by firmly plugging

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COMPLETE LONGITUDINAL DIVISION (LINEAR PROCTOTOMY)

Indications. This operation is suitable for a long tubular stricture, extending from the anal canal upwards for even 3 or 4 inches, especially for cases complicated by fistulæ.

Operation. The patient being placed in the lithotomy position, the operator passes his left forefinger as far as possible into the rectum, through the stricture if this be permeable, and if not, as far as its commencement. A curved sharp-pointed bistoury is introduced along the finger, and the edge is then turned towards the sacrum. The point is made to transfix the bowel, if possible above the stricture, and is brought out through the skin at the tip of the coccyx, all the intervening tissues being thus divided. If the upper part of the stricture has escaped division, the edges of the wound should be held apart with retractors, and the division completed with knife or scissors, under the guidance of both finger and eye. Thus a triangular gap is made with the apex above and the base below. After all bleeding has been stopped, the wound is well flushed with 1 in 2,000 perchloride of mercury lotion and packed with gauze after the insertion of the rectal tube. There need be no fear of severe hæmorrhage, provided that the incision be made in the median line. If, however, any bleeding should occur which cannot be arrested in the ordinary way, the tube and strips of gauze should be inserted as before described.

After-treatment. The wound must be syringed night and morning with a non-poisonous antiseptic solution and lightly packed with cyanide gauze.

Dilatation by means of bougies must be persisted in for a considerable time after this and the above operations, or recontraction will take place.